CPC 100

User Manual

Manual Information

Article Number VESD0601 - Manual Version: CPC100LITE.ENU.10

With respect to the functionality of the *CPC 100* software, this manual refers to the version **V 3.10**.

This product includes software developed by Intrinsyc Software.

The product information, specifications, and technical data embodied in this manual represent the technical status at the time of writing and are subject to change without prior notice.

We have done our best to ensure that the information given in this manual is useful, accurate and entirely reliable. However, OMICRON electronics does not assume responsibility for any inaccuracies which may be present.

The user is responsible for every application that makes use of an OMICRON product.

OMICRON electronics translates this manual from the source language English into a number of other languages. Any translation of this manual is done for local requirements, and in the event of a dispute between the English and a non-English version, the English version of this manual shall govern.

Support

When you are working with our products we want to provide you with the greatest possible benefits. If you need any support, we are here to assist you!

24/7 Technical Support – Get Support

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Offering our customers outstanding support is one of our top priorities. At our technical support hotline, you can reach well-educated technicians for all of your questions. Around the clock – competent and free of charge.

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Preface

About this User Manual

The purpose of this User Manual is to get you started quickly. It guides you directly to the various *CPC 100* application fields, shows the typical test setup, the corresponding *CPC 100* test card, and outlines the parameters used for this test in a compact form.

Since the scope of this User Manual is confined to the most important information about a specific subject, the CPC 100 User Manual complements the CPC 100 Reference Manual, however, it does not replace it. The CPC 100 Reference Manual is available in PDF format on the *CPC 100 Toolset* CD-ROM and the *CPC 100 Start Page*.

Reading the CPC 100 User Manual alone does not release the user from the duty of complying with all national and international safety regulations relevant for working with the *CPC 100*, for example, the regulation EN50191 "Erection and Operation of Electrical Test Equipment" as well as the applicable regulations for accident prevention in the country and at the site of operation.

Conventions and Symbols Used

In this manual, the following symbols indicate paragraphs with special safety relevant meaning:

Symbol	Description
	Equipment damage or loss of data possible.
	Personal injury or severe damage to objects possible.

Safety Instructions for the *CPC 100* and its Accessories

Caution: The *CPC 100* must be used in observance of all existing safety requirements from national standards for accident prevention and environmental protection.

Before operating the *CPC 100*, read the following safety instructions carefully. It is **not recommended** that the *CPC 100* be used (or even turned on) without understanding the information in this manual. If some points of the safety instructions are unclear, contact OMICRON electronics.

Principle Use According to Regulations

- The *CPC 100* should only be used in a safe manner, mindful of the dangers while paying attention to the User Manual, and when it is in a technically sound condition and when its use is in accordance with the regulations. In particular, avoid disruptions that could in turn affect safety.
- ***DANGER:*** If you have a cardiac pacemaker, do not use the *CPC 100*! Before operating the *CPC 100*, make sure there is no person with a cardiac pacemaker in the immediate vicinity.
- The *CPC 100* is exclusively intended for the application fields specified in detail in ”Designated Use” on page Preface-2. Any other use is deemed not to be according to the regulations. The manufacturer/distributor is not liable for damage resulting from improper usage. The user alone assumes all responsibility and risk.
- Following the instructions provided in this User Manual and in the CPC 100 Reference Manual available in PDF format on the *CPC 100 Toolset* CD-ROM and the *CPC 100 Start Page* is also considered part of being in accordance with the regulations.
- Do not open the *CPC 100* housing.
- If you do not use the *CPC 100* anymore, turn the safety key to "lock" (vertical) and remove the key to avoid anybody accidentally turning on the *CPC 100*.
- Store key and the *CPC 100* separately to prevent unauthorized personnel from using the *CPC 100*.

Orderly Measures

- This User Manual only complements the CPC 100 Reference Manual available in PDF format on the *CPC 100 Toolset* CD-ROM and the *CPC 100 Start Page*. However, it does not replace it.
- Either this User Manual or the CPC 100 Reference Manual should always be available on the site where the *CPC 100* is being used.
- Personnel assigned to use the *CPC 100* should carefully read the CPC 100 User Manual/ Reference Manual - in particular the section on safety instructions - before beginning to work with it. On principle, this also applies to personnel who only occasionally work with the *CPC 100*.
- Do not undertake any modifications, extensions, or adaptations to the *CPC 100*.
- Use the *CPC 100* in conjunction with original accessories only.

Operator Qualifications and Primary Responsibilities

Warning: Testing with the *CPC 100* should only be performed by authorized and qualified personnel. Clearly establish the responsibilities.

Personnel receiving training, instruction, direction, or education on the *CPC 100* should remain under the constant supervision of an experienced operator while working with the equipment.

Safe Operation

When putting the *CPC 100* into operation, follow the instructions in section "Putting CPC 100 into Operation" in the CPC 100 Reference Manual (available in PDF format on the *CPC 100 Toolset* CD-ROM or the *CPC 100 Start Page*).

Note: Never use the *CPC 100*, any accessory or the *CP TD1* equipment trolley without a solid connection to earth with at least 6 mm². Use a ground point as close as possible to the operator.

Designated Use

The *CPC 100*, in conjunction with its accessories or as a stand-alone unit, is a multi-purpose primary test set for commissioning and maintaining substation equipment. It performs current transformer (CT), voltage transformer (VT) and power transformer (TR) tests. Furthermore, it is used for contact and winding resistance testing, polarity checks as well as primary and secondary protection relay testing.

The various, partly automated tests are defined and parameterized via the front panel control of a built-in embedded PC.

The functionality scope of the *CPC 100* is described in detail in the chapter "Designated Use" of the CPC 100 Reference Manual available in PDF format on the *CPC 100 Toolset* CD-ROM or the *CPC 100 Start Page*.

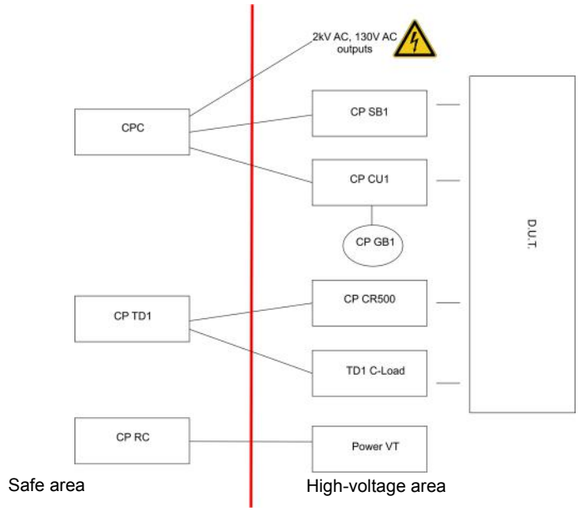
Note: Any other use of the *CPC 100* but the one mentioned above is considered improper use, and will not only invalidate all customer warranty claims but also exempt the manufacturer from its liability to recourse.

FOR YOUR OWN SAFETY

Always follow the 5 safety rules:

1. Insulate
2. Secure to prevent reconnecting
3. Check isolation
4. Earth and short-circuit
5. Cover or shield neighboring live parts

Warning: Do not enter the high-voltage area if the red warning light of the *CPC 100* is on since all outputs carry dangerous voltage or current! Always obey the five safety rules and follow the detailed safety instructions in the respective user manuals.



Example for the separation of safe and high-voltage area using different OMICRON electronics GmbH devices

Safety Instructions for the *CPC 100* and its Accessories

General

- Before connecting or disconnecting test objects and/or cables, turn off the *CPC 100* by either the POWER ON/OFF switch or the Emergency Stop button. Never connect or disconnect a test object while the outputs are active.

  Note: Even if you switched off the *CPC 100*, wait until the red I/O warning light is fully extinguished. As long as this warning light is lit, there is still voltage and/or current potential on one or more of the outputs.

- Make sure that a test object's terminals that are to be connected to the *CPC 100* do not carry any voltage potential. During a test, the only power source for a test object may be the *CPC 100*.
- At their output sockets and especially in the cables connected to them, in operation the high-current outputs **400A DC** and **800A AC** generate a significant amount of heat (approx. 300W/m at 800A). To prevent burns, use gloves when touching the cables while in operation or a short while after.
- Do not insert objects (e.g., screwdrivers, etc.) into any input/output socket.
- Never use the test cards **Quick** and **Resistance** to measure the resistance of windings with a high inductance because turning off the DC source results in life-threatening voltage levels. For this kind of measurement only use either the special winding resistance test card **RWinding** or the test card **TRTapCheck**!

Warning: When measuring the ratio of voltage and power transformers make sure that the test voltage is connected to the corresponding high-voltage winding, and the voltage of the low-voltage winding is the one that is measured. Accidentally mixing up the windings can generate life-threatening voltages within the transformer.

Warning: Make sure that when testing a current transformer by feeding a test current into its primary winding, all secondary windings are shorted. On open secondary windings, life-threatening voltages can be induced!

Safety Instructions for the *CPC 100* and its Accessories

- Use only one *CPC 100* output at a time.
- All AC and DC output sockets of the *CPC 100* can carry life-hazardous voltage potential and provide life-hazardous currents. Therefore:
  - While connecting cables to the *CPC 100* high-voltage or current outputs, or other conducting parts that are not protected against accidental contact, press the Emergency Stop button, and keep it pressed as long as an output signal is not absolutely necessary for the test.
  - When connecting to the front panel input/output sockets, use wires with either 4 mm safety "banana" connectors and plastic housing or, where applicable, with the especially manufactured counterpart supplied by OMICRON electronics (e.g., for the **V2 AC** measuring input).
  - For the high-voltage and current output connectors on the left-hand side of the test set (2kV AC, 400A DC and 800A AC, Ext. Booster), only use the specially manufactured cables supplied by OMICRON electronics (refer to the chapter "Accessories" of the CPC 100 Reference Manual available in PDF format on the *CPC 100 Toolset* CD-ROM or the *CPC 100 Start Page*).
  - One end of the high-voltage cable has a coaxial safety plug that is certified for a voltage level of 2kV AC. The other end is equipped with a safety banana plug that is insulated with a shrink tube.

Warning: When the *CPC 100* is switched on, consider this part of the cable a hazard of electric shock!

  - If you do not use the high-current outputs **400A DC** or **800A AC**, or the high-voltage output **2kV AC**, disconnect any cable that may be plugged in to these sockets.

Note: The 400A DC or 800A AC outputs are not switched off by internal relays. Therefore, if a test mode is selected that does not use either one of these two outputs, they still generate current.

  - Do not stand right next to or directly underneath a connection point because the clamps may fall off and touch you.
    This is a physical and an electrical hazard.
  - The red warning light on the *CPC 100* front panel indicates hazardous voltage and/or current levels at the *CPC 100* outputs (red light "I" on or flashing). The green warning light indicates that the *CPC 100* outputs are not activated.

Note: If none or both warning lights are on, the unit is defective and must not be used anymore.

  - Both of the high-current output sockets on the left-hand side of the test set (**400A DC** and **800A AC**) usually carry a relatively low-voltage potential.

Warning: However, in case of an internal insulation fault these outputs may carry up to 300 V. Consider these outputs life-hazardous!

  - Always lock connectors properly.

The counterpart of the high-current sockets are locking connectors.

To lock these connectors safely, insert them carefully until you feel a "click" position. Now they are locked. Confirm this by trying to pull them out. This should not be possible now.

To remove the locking connectors, unlock them by pushing them in completely first, and then pull them out.

- The high-current cables for both the **800A AC** and **400A DC** outputs are equipped with connection clamps at one end. If these connection clamps are attached to a test object's terminal that is situated above your head, make sure the clamp is securely attached. Due to the weight of the cables the clamp may become loose and fall down.
- Do not operate the *CPC 100* under ambient conditions that exceed the temperature and humidity limits listed in "General" on page Technical Data-3.
- Do not operate the *CPC 100* in the presence of explosives, gas or vapors.
- If the *CPC 100* or any add-on device or accessory does not seem to function properly, do not use it anymore. Please call the OMICRON electronics hotline (refer to cover page of this User Manual.

Power Supply

- Supply the *CPC 100* only from a power outlet that has protective earth (PE).
- An error message (313) appears if either the PE connection is defective or the power supply has no galvanic connection to ground. In this case, make sure that the PE connection is intact. If the PE connection is intact and the error message still appears, select the "Disable ground check" check box at the **Device Setup** tab in the **Options** view.
- Ground the isolating transformer outputs or generators used to supply the *CPC 100* on the N (neutral) output or select the "Disable ground check" check box as described above.
- Instead of supplying the *CPC 100* from phase - neutral (L1-N, A-N), it may also be supplied from phase - phase (e.g., L1-L2; A-B). However, the voltage must not exceed 240V AC.
- Fuse-protect the power supply (16A slow-acting fuse).
- Do not use an extension cable on a cable reel to prevent an overheating of the cord; run out the extension cord.

Caution: The connector “Ext. Booster” is **always** galvanically connected to mains, regardless whether or not an external booster is selected on the software tab **Options | Device Setup,** the green warning light (0) is on, the outputs are turned off or the Emergency Stop button is pressed.
Handle with extreme caution. Do not use any other booster cables than the ones supplied by OMICRON electronics.

Changing Fuses

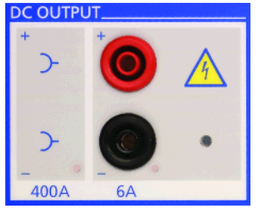
- Turn off the *CPC 100*, unplug the power cord and/or press the Emergency Stop button.
- We recommend to wait for about 30 seconds. This time is necessary for the internal electrolytic capacitors to fully discharge.
- Ground the test object, and disconnect it from the *CPC 100*. By disconnecting it, you prevent a possibly faulty test object feeding power back into the *CPC 100*.
- Locate the blown fuse on the front panel of the *CPC 100*, and replace it.

Note: Replace with identical fuse type only (refer to the chapter "Changing Fuses" of the CPC 100 Reference Manual available in PDF format on the *CPC 100 Toolset* CD-ROM or the *CPC 100 Start Page*).

DC Output to Test Objects with a High Inductance

Use test cards **RWinding** (winding resistance) and **TRTapCheck** (tap changer winding resistance and on-load tap changer interruption check) only:

Warning: As long as the *CPC 100* software shows the on-screen message “Switch off in progress”, NEVER connect or disconnect test objects and/or cables.



The message "Switch off in progress" notifies you that, after the *CPC 100* was switched off, the connected external inductance (i.e., the test object) still "feeds" voltage potential back into the **6A DC** or **400A DC** output.

The existence of this voltage potential at the **6A DC** output is also indicated by a lit LED - even if the *CPC 100* is switched off.

If a test object with a big inductance is connected to the *CPC 100*, ground the test object on both ends before disconnecting it from the *CPC 100.*

Warning: The *CP SA1* discharge box must be connected to the *CPC 100*'s **V DC** input sockets when using the **400A DC** output to protect yourself and the *CPC 100* from high-voltage hazards.

If a test object with a big inductance was connected to the *CPC 100*, short-out the test object additionally before disconnecting it from the *CPC 100.*

Warning: Use separate clamps for current and voltage connections on both sides of the test object to avoid hazards in case one clamp falls off during the test.

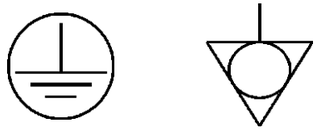
CPC 100 in Combination with the *CP TD1*

The *CP TD1* is an optionally available high-precision test system for on-site insulation tests of high-voltage systems like power and measuring transformers, circuit breakers, capacitors and isolators. The *CP TD1* works as an add-on device to the *CPC 100* and is described in chapter ”CP TD1” of this User Manual.

On principle, the safety instructions that apply to the *CPC 100* and its accessories also apply to the *CP TD1*. However, the *CP TD1* requires some additional precautions and measures. They are listed in chapter ”CP TD1” on page CP TD1-1.

Different Symbols for PE

The *CPC 100* and *CP TD1* use different symbols for protective earth (PE):



This is due to a new standard and does not symbolize any functional difference.

Note: Both symbols mean exactly the same, i.e., protective earth (PE) or equipotential ground.

Introduction

Functional Components of the *CPC 100*

I / 0 warning lights
indicate either a safe operation, i.e., no voltage at the *CPC 100* outputs (green light "0" on), or an operation with possibly hazardous voltage and/or current levels at the *CPC 100* outputs (red light "I" on or flashing).

Safety key lock
Locks front panel operation.

BIN IN
Binary trigger input, wet or dry contact

IAC/DC INPUT
Fuse-protected with a 10A very quick-acting fuse

Fuse 6.3A T (slow-acting wire fuse 5x20 mm)
for 3A AC, 6A AC, 130V AC and 6A DC

AC OUTPUT
6A, 3A or 130V output

Fuse 3.15A (slow-acting wire fuse 5x20 mm)
for 3A AC and 130V AC

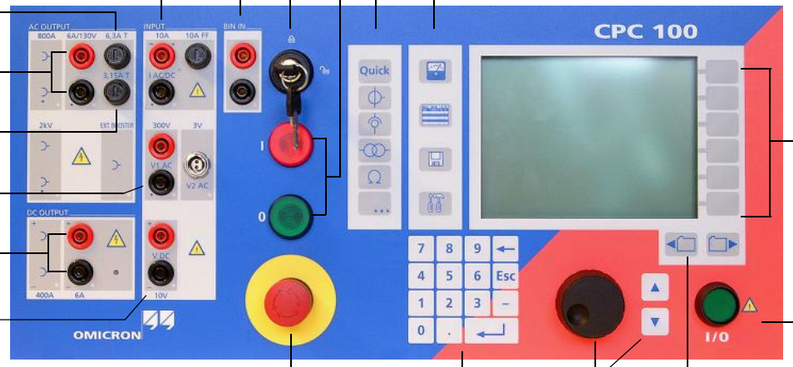
V1 AC input
300V AC input

V2 AC input
3V AC input

DC OUTPUT
6A DC output (fuse-protected with a 6A fuse)

VDC INPUT
10V DC input or 2-wire resistance

Emergency Stop button
Immediately shuts off all outputs (could leave transformer in saturation).



Soft-touch keyboard

Navigation elements

Add test cards
We recommend not to use more than 15 test cards or 50 test results in one test procedure.

Test Card View: View to set up test cards, compose test procedures, enter test settings, define test cards or the test procedure default, start tests etc.

Test Procedure Overview: Provides an enhanced overview of all test cards of the currently active test procedure. Defines the test procedure default.

File Operations: Lets you save, load, delete, copy and rename test procedures.

Options: To specify general parameters.

Context-dependent menu keys
Directly invoke specific commands associated with the currently selected control of the test card and view.

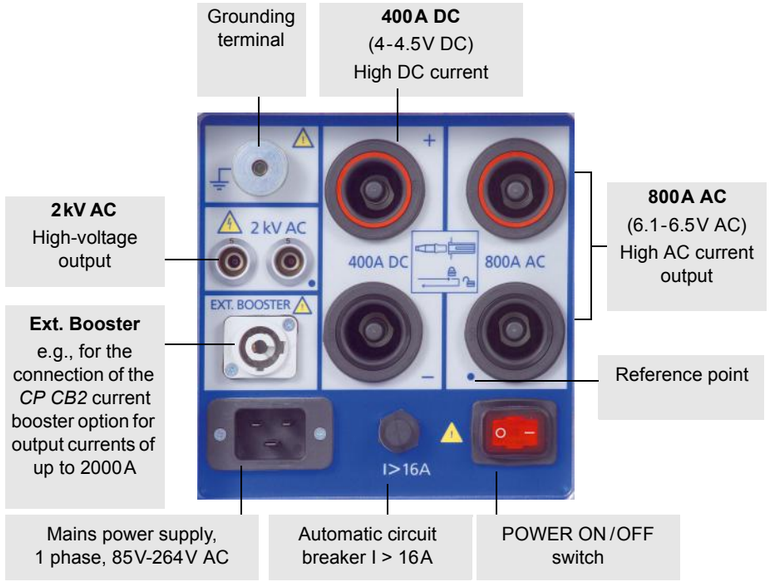
I/O
Use to start and stop a test.

Tab selector
To change between the single test cards of a test procedure.

Functional Components of the *CPC 100*

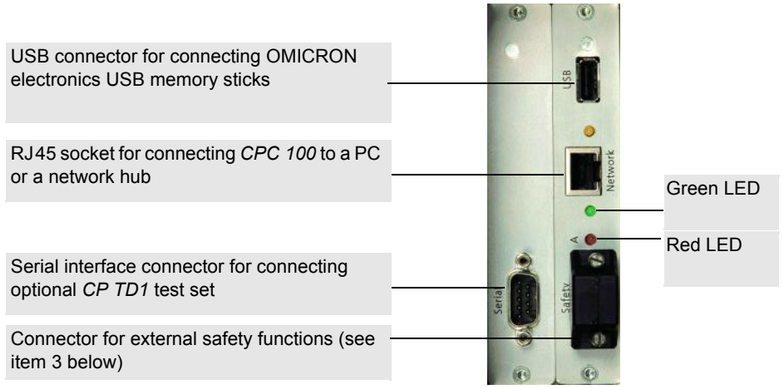
High-Voltage and Current Outputs

When the *CPC 100* outputs high current, observe the allowed duty cycles that may apply to the selected AC output range.



Warning: The connector "Ext. Booster" is **always** galvanically connected to mains, regardless whether or not an external booster is selected on the software tab **Options | Device Setup**, the green warning light (0) is on, the outputs are turned off or the Emergency Stop button is pressed. Use only original accessories available from OMICRON electronics.

ePC Interfaces[1]



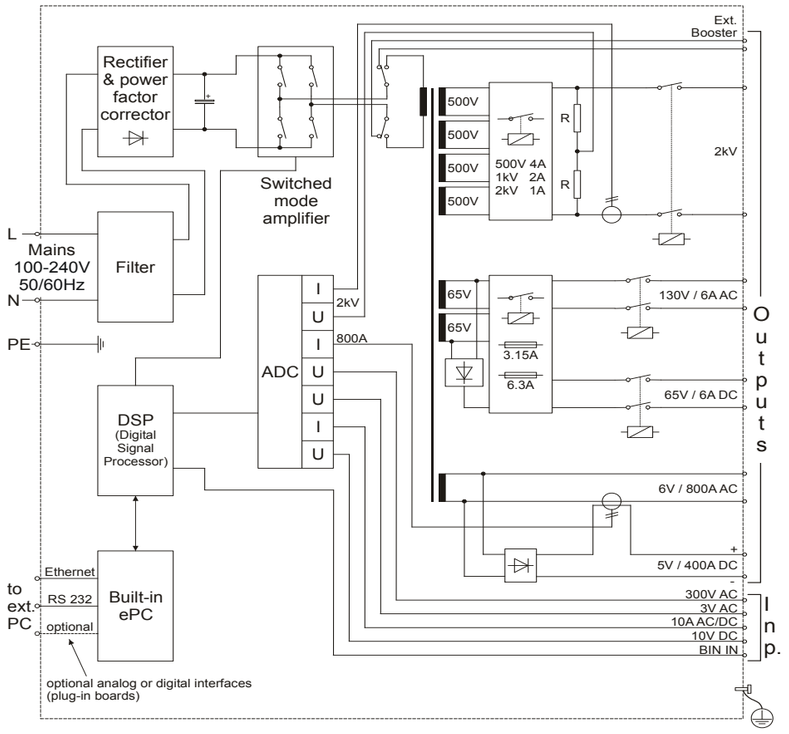
1. Older *CPC 100* versions have slightly different ePC interfaces. For detailed information refer to the CPC 100 Reference Manual.

1. For detailed information on the RJ45 connectors, see chapter "CPC 100 in a Network" in the CPC 100 Reference Manual available in PDF format on the *CPC 100 Toolsets* or *CPC 100 Start Page*.
2. For the pin assignment of the RS232 serial interface plug, refer to the CPC 100 Reference Manual, section "ePC Interfaces" of chapter "Technical Data".
3. The connector for external safety functions allows connecting:
   - an external Emergency Stop button
   - an external "test start/stop" push-button
   - external I/O warning lights
   - *CP CR500*

   The attached plug contains a jumper for the emergency stop or "dead man" function, and as long as the plug is placed on the connector, these functions are bridged. If the plug is removed, emergency stop is active.

   For the plug's pin assignment and a wiring scheme, refer to section "Connector for External Safety Functions" of chapter "Technical Data" in the CPC 100 Reference Manual available in PDF format on the *CPC 100 Toolsets* or *CPC 100 Start Page*.

CPC 100 Block Diagram



Principles of Test Cards and Test Procedures

Test Cards

The *CPC 100* software comprises a number of test cards. A test card carries out one specific test, e.g., measuring a CT excitation curve, or testing the ratio of a voltage transformer.

A test card holds a number of user-definable test settings and - after the test was run - test results.

Test Procedure

A test procedure contains multiple test cards.

The composition of such a test procedure and the settings of all single test cards can be freely defined by the user. Within a test procedure, each test card and its associated test is executed individually in a user-defined order.

Report

For archiving or reporting purposes, or later processing, a test procedure with all of its test cards, specific settings and - after the test was run - test results and assessments can be saved. It is then considered a report.

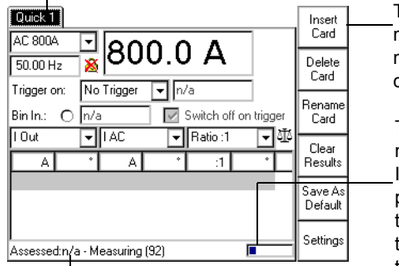
Such a report can later be opened any time in the *CPC 100*'s **File Operations** menu.

Note: For detailed information about test cards, test procedures and templates, refer to section "How to Use The CPC 100 Software" of chapter "Introduction" in the CPC 100 Reference Manual available in PDF format on the *CPC 100 Toolsets* or *CPC 100 Start Page*.

The Components of a Test Card

Focus on the data entry field for AC current.

The term "focus" designates the currently selected (active) part of the test card. The selected component is highlighted or inverted.



Status of test assessment. The test assessment is a manual procedure carried out by the user. After the test, set the focus on the assessment symbol. Use the context-dependent menu key **OK** or **Failed** to assess the test.
For a few seconds, the status line also displays general operation information, e.g. "Emergency key pressed".

The actual function of the context-dependent menu keys depends on the selected view, test mode, test card and selected test card component (i.e., the focus).

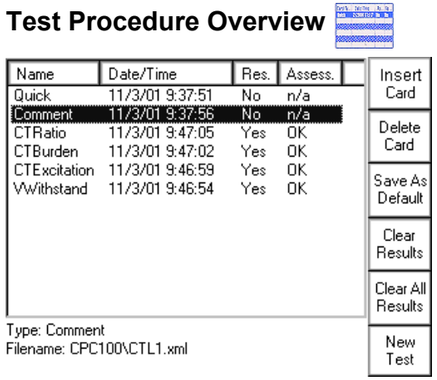
Temperature and power consumption monitoring.
If an output is activated, both the *CPC 100*'s power consumption and the current emitted at the high-current outputs is monitored and, together with the temperature, displayed by this temperature gauge.
The temperature gauge's bar therewith represents an indicator for the remaining time the *CPC 100* can output power.

plenty of spare

no more spare

Pressing the **Settings** menu key opens the **Settings** page (see page Quick-1) allowing you to set the test cards individually. As a rule, do not set the test cards on the **Settings** page but set all test cards of a test procedure using the **Device Setup** tab in the **Options** view (see page Introduction-5).

Test Procedure Overview



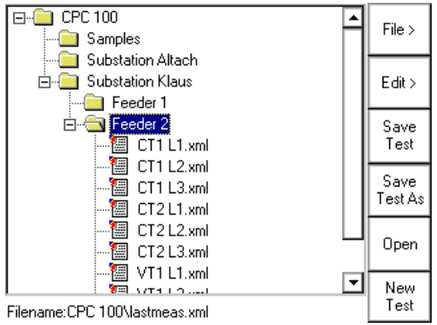
The Test Procedure Overview lists all test cards of the currently active test procedure in a list box showing the card's name, its creation date and time, whether test results are available and the test card's assessment status.

With **Save As Default**, Test Procedure Overview provides a function to save the current test procedure as the test procedure default, i.e., that default the *CPC 100* software will start with in future.

Note: For detailed information refer to section "Test Procedure Overview" of chapter "Introduction" in the CPC 100 Reference Manual available in PDF format on the *CPC 100 Toolsets* or *CPC 100 Start Page*.

The *CPC 100* File System

The highest hierarchical level of the *CPC 100* file system, the "root", is named **CPC 100**. Below this, you can create additional folders in a tree-structure of your choice, save tests in these folders, and perform file operations, such as open, save, rename, copy, paste etc.



The *CPC 100* file system differentiates two file types:

`name.xml` A test procedure with all of its test cards and specific settings. An .xml file may also contain test results and assessments that were stored together with the settings as report in the *CPC 100* file system for archiving purposes.

`name.xmt` Test procedure template, i.e., a user-defined template containing one or more test cards with all of their specific test settings but without test results.

Note: The file containing the up-to-date measurements should be saved regularly. If the test unit is switched off, or in case of a power outage, all unsaved measurements will be lost.

Navigating Through the File System

Select a test or a folder using the handwheel or the **Up / Down** keys. To expand a collapsed folder tree  , select it and press either the handwheel or **Enter**.

The Menus

Main File Operations Menu

Opens the submenu **File** (refer to "Submenu File" on page 5)

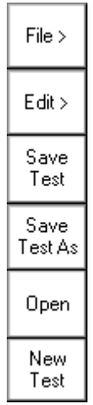
Opens the submenu **Edit** (refer to "Submenu Edit" on page 5)

Saves the currently open test, i.e., the test card(s) previously opened in the Test Card View (refer to Note below).

Opens the **String Editor**. You can save the currently open test under a new name of your choice (15 characters max.).

Use the handwheel or the **Up / Down** keys to select a test, and press **Open** to open it. Changes to Test Card View.

Closes the current test card(s), changes to Test Card View and opens the test procedure default.



The *CPC 100* File System

Note: Unlike the other menu items, the two **Save…**functions of the main **File Operations** menu directly effect the currently open test, i.e., the test procedure that was composed in the Test Card View, or the test that was loaded in the *CPC 100* file system beforehand.
Therefore, pressing **Save**, for example, does not save the test that you may have highlighted in the folder tree, but the one that is currently open.

Submenu File

Opens the **String Editor**. You can create a new folder with any name of your choice.

Appends the contents of a test file (`.xml`) or template (`.xmt`) of your choice to the currently open test.

Deletes the currently selected test or folder from the *CPC 100*'s disk space.

Opens the **String Editor** that enables you to rename the current test to any new name of your choice.

(for future use)

Closes the submenu and returns to the main **File Operations** menu.

Submenu Edit

Select the test of your choice. Press **Cut** to put the selected test or folder to the Clipboard. Proceed with **Paste…**

Select the test of your choice. Press **Copy** to copy test or folder to the *CPC 100* clipboard. Proceed with **Paste…**

Move to the destination folder of your choice. Press **Paste** to insert the contents of the *CPC 100* clipboard to this folder.

Press **Paste As Templ.** to make the contents of the *CPC 100* clipboard a test procedure template.

(for future use)

Closes the **Edit** submenu and returns to the main File Operations menu.

Note: If a folder is cut or copied to the Clipboard, the selection is recursive, i.e., all of its subfolders will also be put to the Clipboard.
Cutting or copying a test or folder, and trying to paste it in the same location, opens the **String Editor**.
Since a test or folder cannot exist twice under the same name at the same location, determine a new name for it using the **String Editor**.

The Options Menu

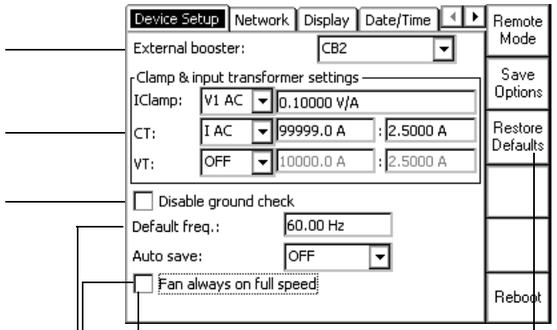
Device Setup

Set the external booster you want to use (CB2, CU20 or CU1).
Set current clamp parameters and CT and/or VT transformation ratio.

Select the check box if the PE connection is intact and an error message (313) appears.
Operating the CPC 100 with the check box selected can cause injury or possibly death of the operating staff!

Set the default frequency. This value will be used for all test cards.

Auto save automatically saves the current test settings in fixed intervals specified to a file named `lastmeas.xml`.



Resets all user-specific settings made in the *CPC 100* software to factory-defined defaults including:

- the test card defaults
- the test procedure default
- all settings made at the **Device Setup** tab (Sets external booster to CB2, sets CT and VT to "OFF" and sets the default frequency to 50 Hz.)
- the String Editor's template strings

If selected, the CPC 100 cools down faster. Thus, the duty cycle can be increased.

The Options Menu

Network

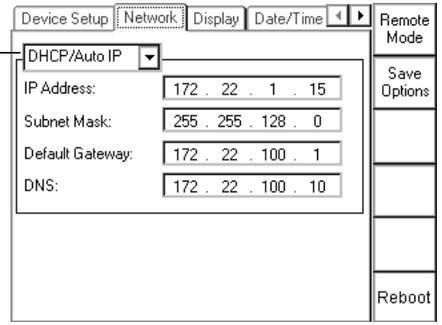
Setting the communication parameters.

DHCP / Auto-IP

Configures all communication parameters automatically; the DHCP server will do it for you or it will be done via the Auto-IP mechanism.
The data entry fields for IP address, Subnet Mask, Default Gateway and DNS are read-only, no data can be entered. This is the recommended setting.

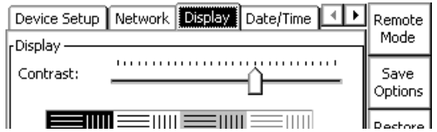
Static IP

Configure the communication parameters manually by entering the values into the data entry fields using the soft-touch keys.



Display

Sliding regulator to adjust the display contrast.



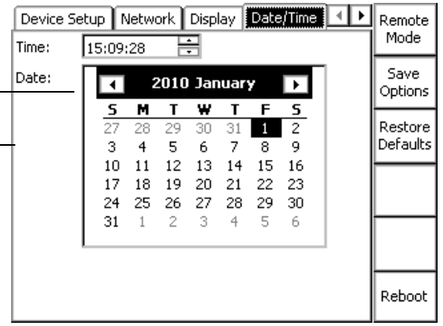
Date / Time

Set date and time.

Set system date.

To set the system time:

- put the focus onto the **Time:** field using the handwheel
- use the **Up/Down** keys to select between hours, minutes and seconds
- turn the handwheel to increase or decrease the value
- press the handwheel to acknowledge your entry.



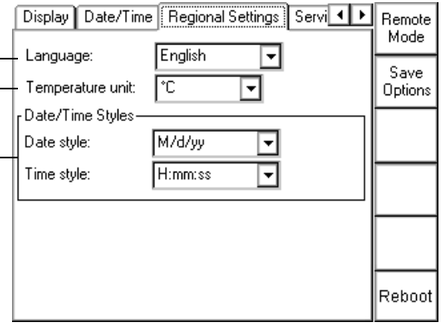
Regional Settings

Regional setting for language, temperature unit, date and time style. These settings affect the way the *CPC 100* software displays and sort dates, times, numbers and decimal points.

Define system language

Define temperature unit °C or °F

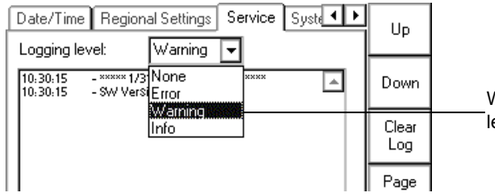
Define the display style for date and time



The Options Menu

Service

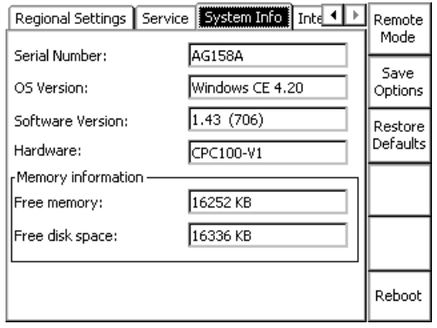
During operation, the *CPC 100* creates a log file with a user-definable logging level.



We recommend to set the logging level to **Warning**.

System Info

Displays system information.



Customizing Your Working Environment

1st Goal: Always Loading Certain Test Cards on System Start-Up

Fill out one or more test card(s) of your choice with the parameters you need.

Change to Test Procedure Overview.

Press **Save As Default**
You have now set the default for the *CPC 100* start-up.

2nd Goal: Loading a Certain Test Card with Always the Same Values

Fill out the test card of your choice with the parameters you want to assign to that card.

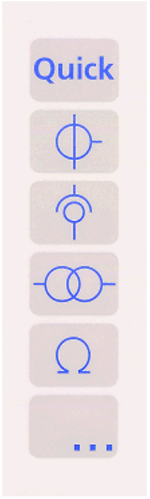
Put the focus to the test card's tab.

Press **Save As Default**
You have now changed the default for this test card type.

The command **Restore Defaults** at the **Options** tab **Device Setup** resets all user-specific settings made in the *CPC 100* software to factory-defined defaults. This includes the test card defaults and the test procedure default.

Accelerator Keys

With the exception of **Quick**, pressing an accelerator key opens the corresponding **Insert a new test card** dialog box and lets you select the test card of your choice. Pressing **Quick** opens the **Quick** test card directly.



Quick test card

Select from current transformer (CT) test cards

Select from voltage transformer (VT) test cards

Select from power transformer test cards

Select from resistance test cards

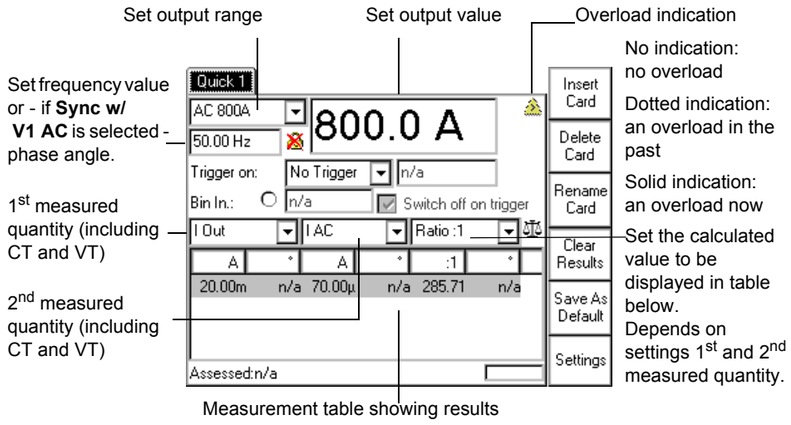
Select from other test applications

Introduction

Quick

CPC 100 V 3.10

Quick is the most basic mode to operate all of the *CPC 100* outputs in a manual-like mode with front panel control.

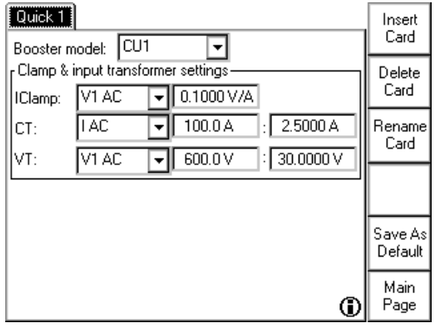


Range

The output range combo box provides a list of available output ranges including either **CB2:**, **CU20:** or **CU1:** output ranges if the respective external booster was selected at the **Options** tab **Device Setup** or on the **Settings** page.

Settings Page

Pressing the **Settings** menu key opens the **Settings** page. The **Settings** page with the exception of the **TRRatio** test card looks as shown below.



The **Settings** page allows setting the test cards individually. At the **Device Setup** tab in the **Options** view (see page Introduction-5), the same properties can be set for all test cards of a test procedure. As a rule, do not use the **Settings** page but the **Device Setup** tab in the **Options** view to set the test cards. Making different settings for the test cards is rarely a good idea. Set the test cards individually using the **Settings** page only in well-founded cases.

If a test card contains results, the settings cannot be changed. When a file containing results is loaded, the **Settings** page can be used to view the settings of the test procedure.

Measuring with Quick

If the output quantities of the selected output can be measured, the combo boxes "1st measured quantity" and "2nd measured quantity" provide **I Out** and / or **V Out** for selection.

I Out sel and **V Out sel** designate the frequency-selective measurement to filter out interferences as they usually occur in substations. The measured input is filtered according to the set output frequency.

After having set all necessary parameters, press the I/O (test start/stop) push button. The **Quick** test card enters the "on" state, the set power output value is switched to the *CPC 100*'s outputs, the measuring continues.

Pressing the **Quick** test card menu key **Keep Results** saves the currently measured values and "freezes" their display in the measurement table. Both the "measuring" and the "on" state remain active, the measurement continues in a new line of the measurement table.

Caution: When testing capacitive test objects using voltages ≥ 500 V, make sure that the test object's capacity does not exceed 25 nF.
Together with the test object's capacity, the leakage inductance of the *CPC 100*'s internal output transformer forms a series resonant circuit. Especially at frequencies > 50 / 60 Hz this may result in voltage superelevation.

Caution: Never use **Quick** to measure the resistance of windings with a high inductance because turning off the DC source results in life-threatening voltage levels.
For this kind of measurement only use the special winding resistance test card **RWinding** or the test card **TRTapCheck**.

Synchronizing Output Frequency with V1 AC

Sync w/ V1 AC

Set **Sync w/ V1 AC** by pressing the menu key that appears when the focus is on the frequency / phase angle data entry field.

This synchronizes the *CPC 100* output frequency with the **V1 AC** input frequency (we recommend a minimum input voltage of 10 V on **V1 AC**, possible range 48 - 62 Hz). In this case the phase angle of the output is displayed rather than the frequency. Set the phase angle value relative to the phase angle of the **V1 AC** input signal.

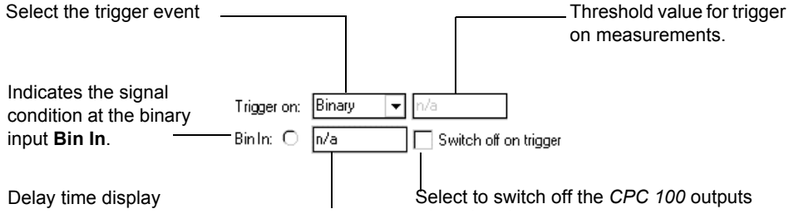
The icon next to the frequency / phase angle data entry field reflects the actual setting.

Due to the PLL (phase locked loop) technology, the synchronization with **V1 AC** takes places about 100 ms after the test was started.

Note: Sync w/ V1 AC is not available in all output modes.

Trigger Settings

A trigger is the occurrence of a selected event, for example, a binary trigger is the first change of the state at the binary input.



Note that some of the trigger events offered in the **Trigger on:** combo box depend on the measured quantity settings below (trigger on measurement).

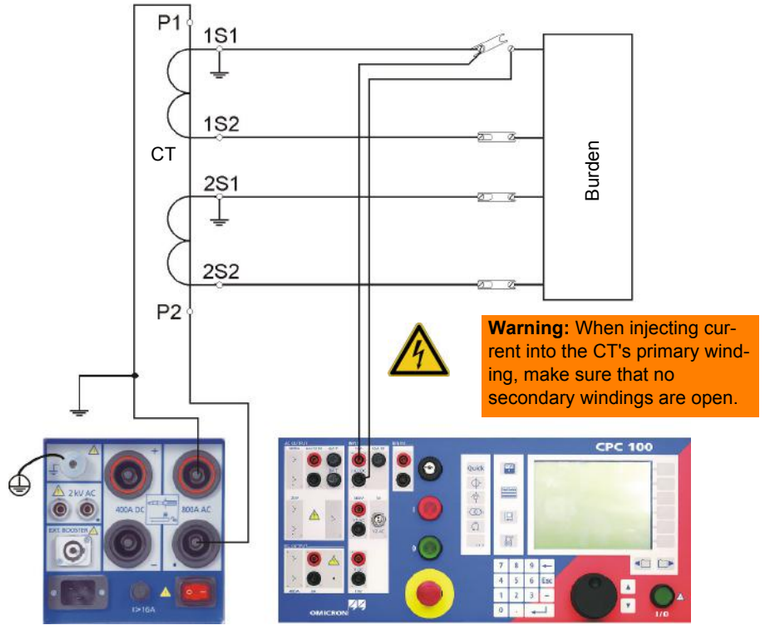
Trigger on "Overload": the occurrence or the clearing of an output overload condition (clearing is delayed by 100 ms to debounce).

Current Transformer

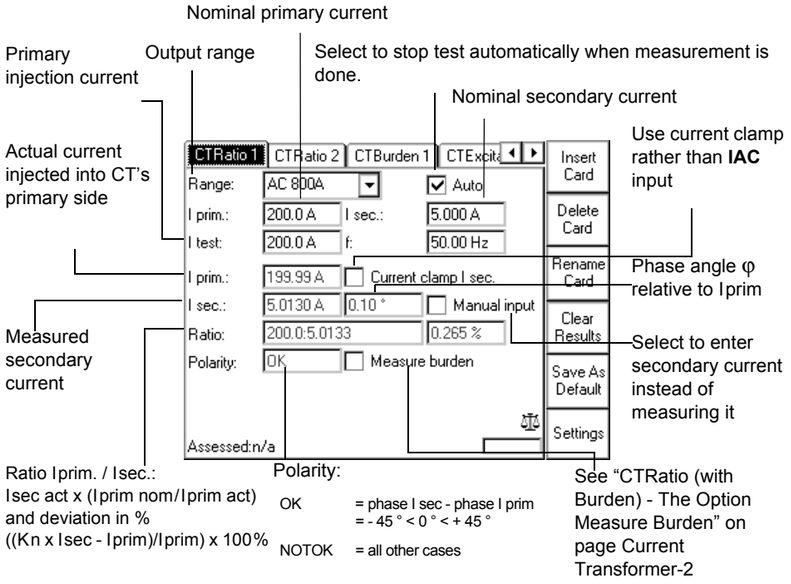
CPC 100 V 3.10

CTRatio (and Burden)

Use the **CTRatio** test card to measure a current transformer's ratio and burden with injection on the CT's primary side with up to 800 A from **AC OUTPUT**.



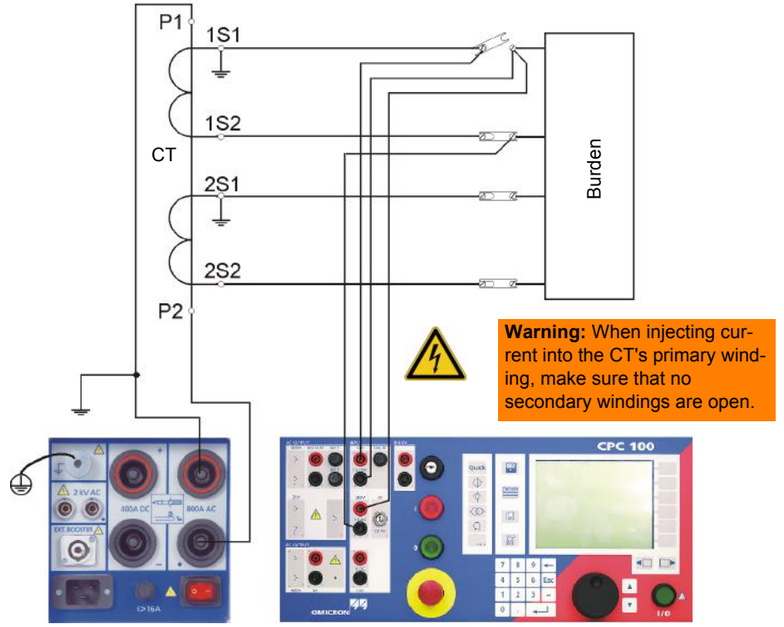
Warning: When injecting current into the CT's primary winding, make sure that no secondary windings are open.



CTRatio (with Burden) - The Option Measure Burden

Select the check box **Measure Burden** to measure the burden in VA.

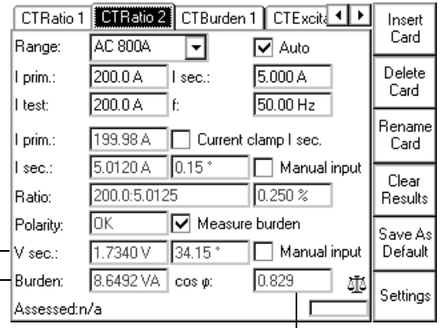
Note: This option is only useful as long as the injected current I test is about of the magnitude of the nominal current I prim.



Warning: When injecting current into the CT's primary winding, make sure that no secondary windings are open.

CTRatio (with Burden) - The Option Measure Burden

Additional measurements when **Measure Burden** is selected:



V sec: measured secondary voltage and phase angle relative to Iprim

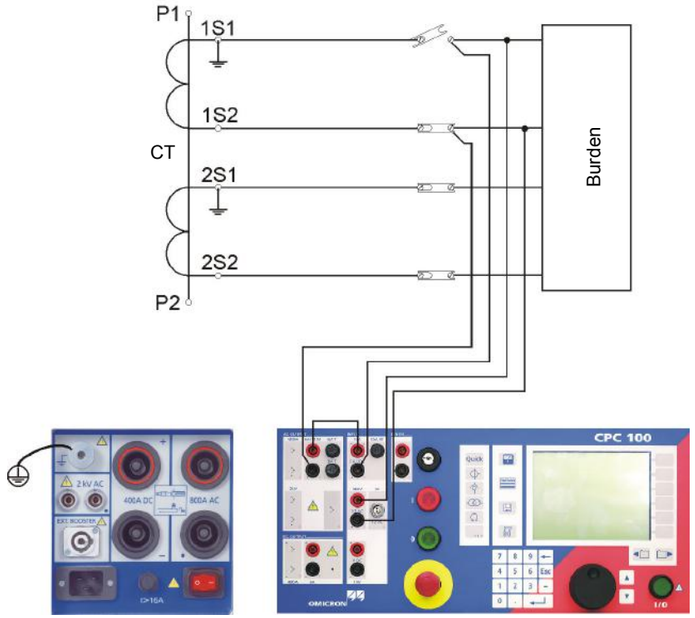
Burden in VA: I sec nom × (V sec act × I sec nom/I sec act)

cos φ: cosine of angle between I sec and V sec

Note: For the meaning of the other test card components, refer to page Current Transformer-1.

CTBurden

This is the preferred method in cases, when the current of max. 800 A that the *CPC 100* can feed into the CT's primary side is not sufficient.



Secondary injection current from **6A AC** output

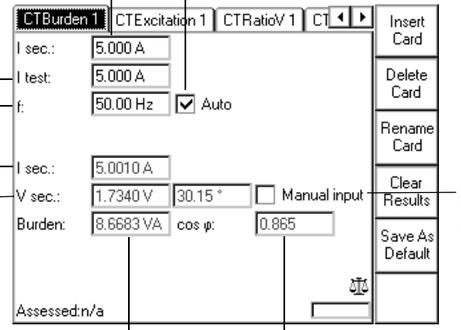
Nominal secondary current

Select to stop test automatically when measurement is done.

Output frequency

Actual injection current measured via input **I AC**

Secondary voltage at the burden, measured at input **V1 AC**, and phase angle φ relative to Isec



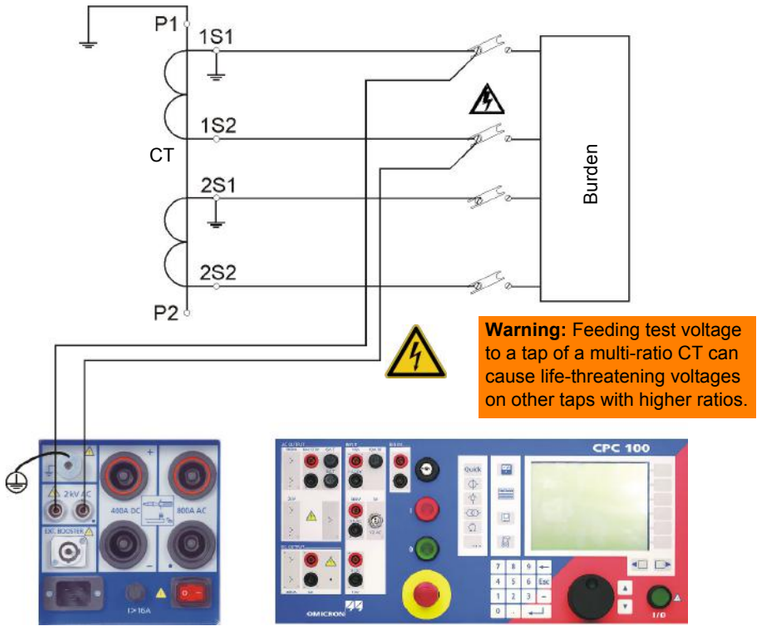
Select to enter secondary voltage instead of measuring it

Cosinus of phase angle φ

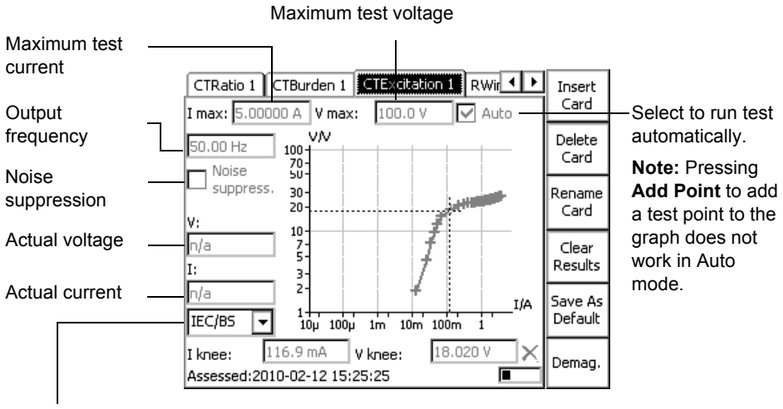
Burden in VA: I sec nom × (V sec act × I sec nom/I sec act)

CTExcitation (Knee point)

Use the **CTExcitation** test card to record the excitation curve of a current transformer. This test performs an automatic injection of a test voltage of up to 2 kV to the current transformer's secondary side.



Warning: Feeding test voltage to a tap of a multi-ratio CT can cause life-threatening voltages on other taps with higher ratios.



Select to run test automatically.

Note: Pressing **Add Point** to add a test point to the graph does not work in Auto mode.

IEC/BS
: According to IEC 60044-1, the knee point is defined as the point on the curve where a voltage increment of 10% increases the current by 50%.

ANSI 45°
: According to IEEE C57.13, the knee point is the point where, with a double logarithmic representation, the tangent line to the curve forms a 45° angle. Applies to current transformer cores without an air gap.

ANSI 30°
: Like ANSI 45° but forming a 30° angle. Applies to current transformer cores with an air gap.

The graph displays the test results in form of an interpolated curve with test point markers.

Turn the handwheel to set the focus onto the graph, and press it. This will bring up a crosshair cursor that lets you navigate through the list of test points by using the keys **Previous Point** and **Next Point**. Turning the handwheel has the same effect. The fields **V:** and **I:** display the value pair of each test point.

Noise suppression: Select if you see unsteadiness and jumps in the CT excitation curve. The unsteadiness or jumps can occur due to noise or disturbance during the measurement.

If noise suppression is selected, the measurement is done with a different frequency.

If $f_{nom} \geq 60$ Hz -> $f_{test} = f_{nom} - 10$ Hz.

If $f_{nom} < 60$ Hz -> $f_{test} = f_{nom} + 10$ Hz.

The voltage will then be calculated back to f_{nom} ($V = V_{meas} * f_{nom}/f_{test}$). With $f_{nom} < 60$ Hz, the maximum test voltage is reduced up to 20% and with $f_{nom} \geq 60$ Hz, the maximum test voltage is increased up to 16%. The exciting current will not be corrected as the influence is very small.

Demagnetizing the CT Core

Performing a CT Excitation measurement demagnetizes the CT core.

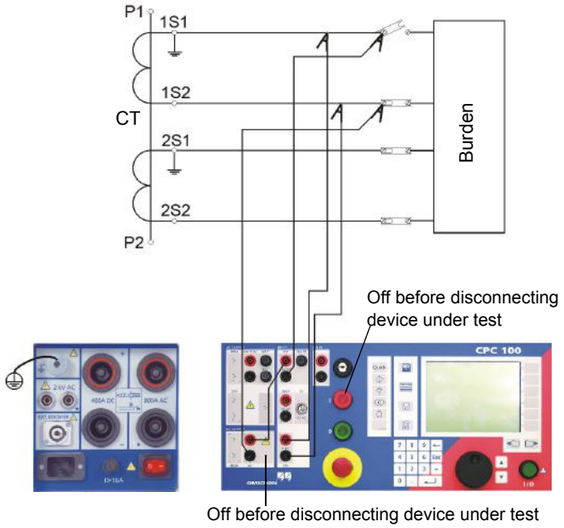
Demagnetization can also be done without recording an excitation curve by pressing the button **Demag.**

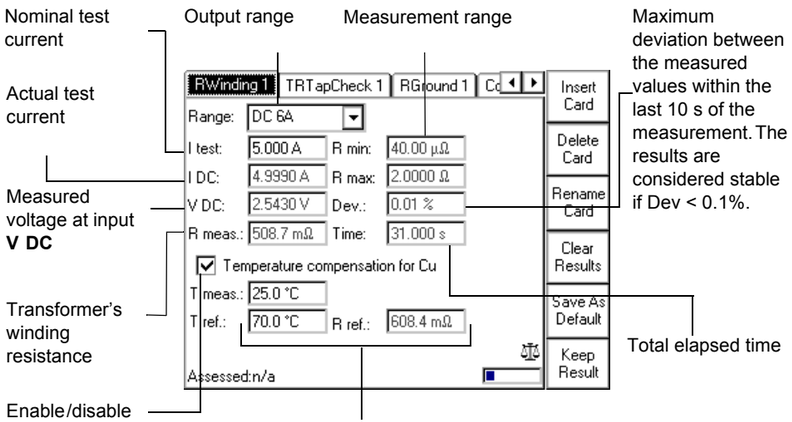
To make the context-dependent menu key **Demag.** visible put the focus onto the test card's tab.

Winding Resistance

Use the test card **RWinding** to measure the resistance of a current transformer's secondary winding.

Warning: Never open the measuring circuit while current flows. Dangerous voltage may occur! Check whether the red warning light "I" and the discharge LED are off before disconnecting the device under test. Before disconnecting from the *CPC 100*, connect the device under test on both ends to protective earth.





T meas: Actual ambient temperature

T ref: Temperature for which the result is calculated

R ref: Calculated resistance.

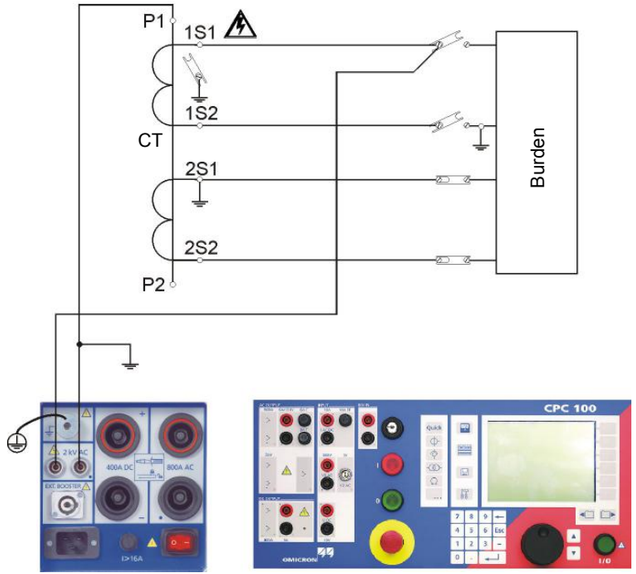
In Centigrade:
Rref = (V DC / I DC) x (235 °C + T ref) / (235 °C + T meas)
In Fahrenheit:
Rref = (VDC / IDC) x (391°F + Tref $_F$) / (391°F + Tmeas $_F$)

Note: Formula according to IEC 60076-1

Note: If n/a appears in the **V DC** or **R meas** box, the **V DC** input is overloaded.

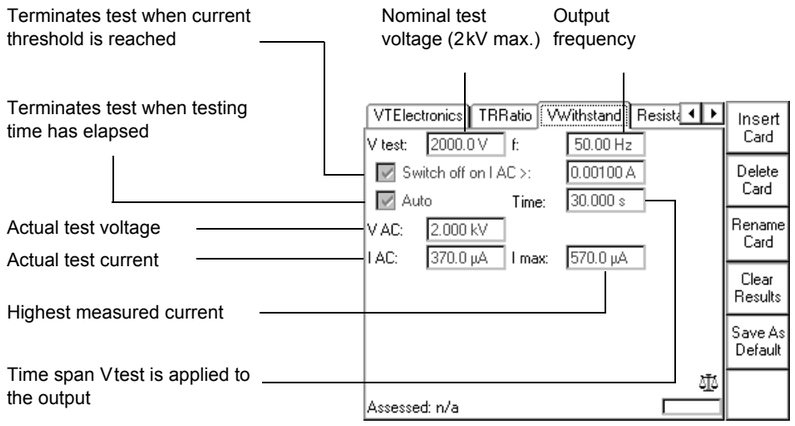
Voltage Withstand Test

Use the test card **VWithstand** to measure the voltage withstand capability of the secondary winding and secondary wiring. To do so, disconnect the burden. As shown in the following figure, connect one cable of the **2 kV** output to the transformer's secondary (1S1) winding connection and the other cable to earth and the transformer's primary connection (P1). Open the secondary ground connection and ground the burden for safety reasons.



Voltage Withstand Test

Warning: Be aware that the terminal that is connected to the transformer's secondary connection "1S1" leads life-hazardous voltage!



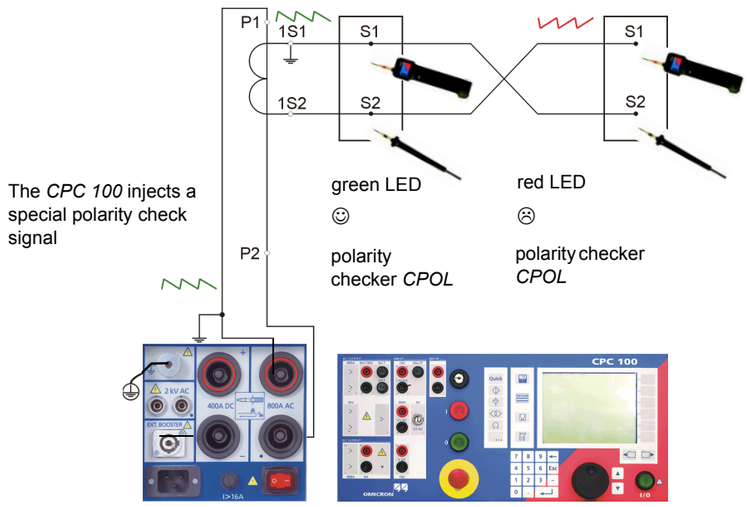
During the test, the test voltage increases in a ramp characteristic from 0 V to **V test**. **V test** is then applied to the output for the specified time span. The measurements are continuously taken. Afterwards, **V test** decreases in a ramp characteristic.

Polarity Check

Use the **PolCheck** test card to check a series of test points for correct polarity.

To do so, the *CPC 100* injects a special polarity test signal at a certain location. This signal can either be a voltage or a current signal from the *CPC 100*, and has a signal characteristic similar to a saw-tooth signal with a different steepness for the rising and the falling slope.

The polarity check itself is then done with the *CPOL* accessory, a portable easy-to-use polarity checker.



☺ If the *CPOL* detects the same signal characteristic at a test point, it considers the polarity as OK, and lights up the green LED.

☹ If the signal characteristic is inverted or distorted, the *CPOL* considers the polarity not OK, and lights up the red LED.

☺ + ☹ If the *CPOL* detects a signal that is too low, both LEDs light up at the same time. Remedy: increase the signal magnitude.

☺ + ☹ flashing If the capacity of the *CPOL*'s battery gets low, the LEDs start flashing. As long as the LEDs are flashing, the *CPOL*'s battery provides sufficient power to continue working. However, the battery should be changed as soon as possible.

Warning: If you detect a wrong polarity in the current path, turn off the *CPC 100* first, and only then disconnect the terminals.
Never operate the *CPOL* with an open battery compartment. A life-hazardous voltage level may occur in the battery compartment if the *CPOL*'s probe touches a test point with high-voltage potential!

Polarity Check

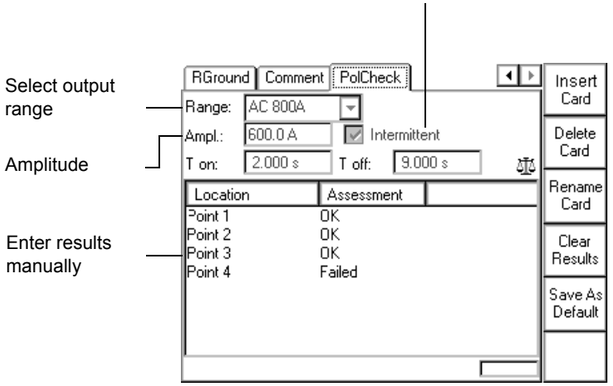
Select the option **Intermittent** to

1. save power in the 800A AC output range
2. define a pulse duty cycle for the output signal:

T on: time span the signal is applied to the output

T off: time span the signal output is paused

A T on / T off ratio of 2.000 s / 9.000 s means the signal is applied for 2 seconds, then paused for 9 seconds. After that the cycle repeats.



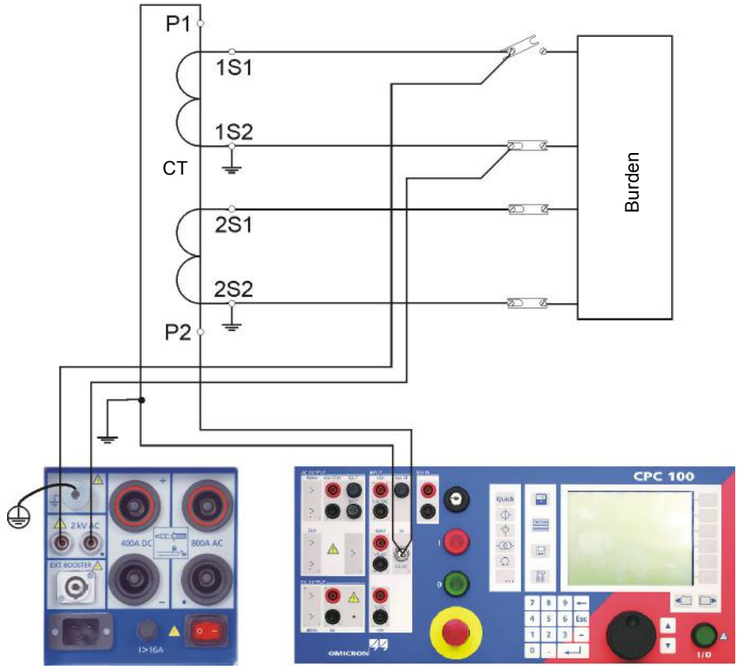
CTRatioV (with Voltage)

Use the **CTRatioV** test card to measure a current transformer's ratio. To do so, feed a voltage of up to 500 V from the **2kV AC** output to the transformer's secondary side.

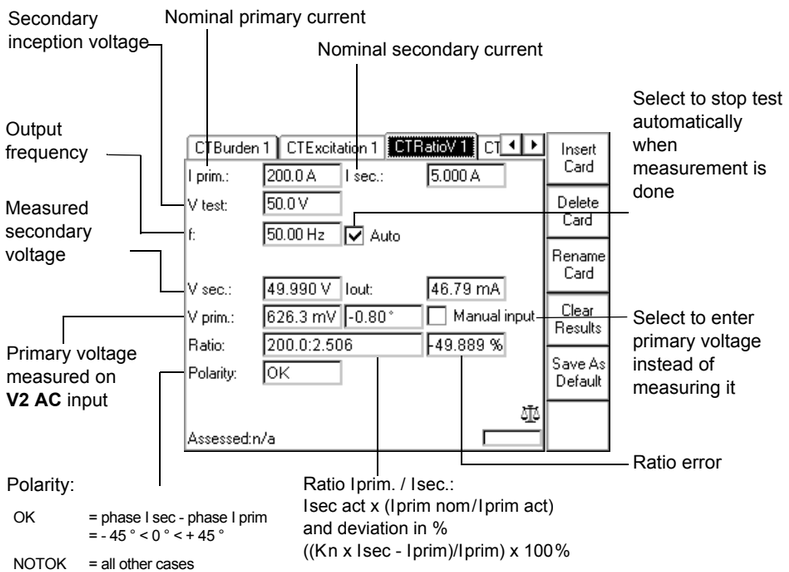
The preferred method for CT ratio measurement is current injection using the **CTRatio** test card. However, on some GIS CTs or bushing CTs on power transformers where the primary current path is not accessible, the method described in this section is the only solution.

To measure the CT ratio using the **CTRatioV** test card, connect the **2kV AC** output to the CT's secondary winding and the **V2 AC** input to the main conductors, e.g. on a power transformer to the transformer's bushings of different phases.

Warning: Feeding test voltage to a tap of a multi-ratio CT can cause life-threatening voltages on other taps with higher ratios.



CTRatio (with Voltage)



Note: If the transformer's knee point voltage is approximated or exceeded, due to the transformer's saturation the measurement results are not correct anymore. If the knee point is extensively exceeded, the transformer can even be damaged.
Therefore, the knee point voltage should be known or measured beforehand.

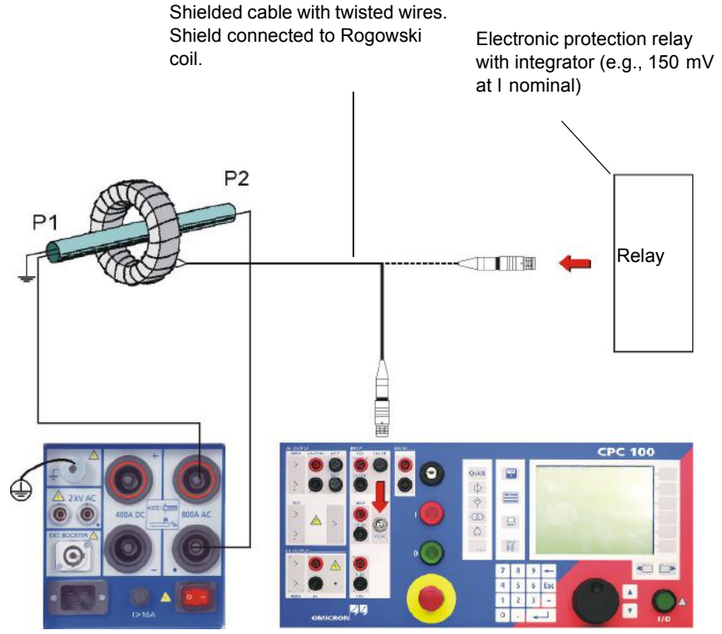
CTRogowski

Use the **CTRogowski** test card to measure a Rogowski coil's ratio by injecting current into the current-carrying conductor, and by measuring the induced voltage at the end of the Rogowski coil windings.

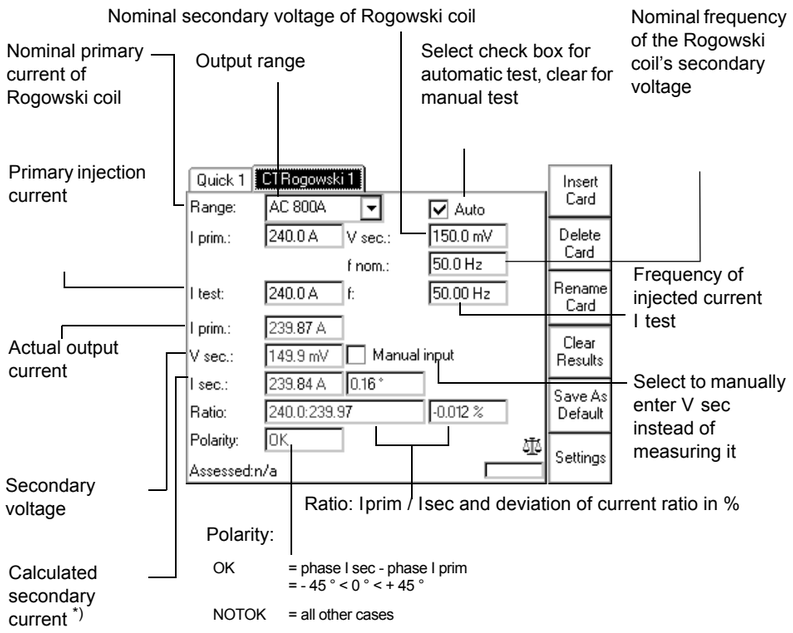
A Rogowski coil's induced voltage is proportional to the conductor current differentiated with respect to time. Therefore, in order to acquire a direct equivalent of the conductor's current, the induced voltage needs to be integrated. In general, a Rogowski coil's output signal is either lead via an integrating amplifier or fed into an electronic protection relay with integrator. The **CTRogowski** test card integrates the Rogowski coil's output signal at the *CPC 100*'s **V2 AC** input.

Disconnect the Rogowski coil's output signal from the electronic protection relay, and plug it into the *CPC 100*'s **V2 AC** input.

The **CTRogowski** test card measures the amplitude of the injected current **I prim** and the Rogowski coil's output voltage **V sec**, integrates this signal, and calculates the secondary current **I sec**, its phase angle as well as the actual ratio and the deviation.



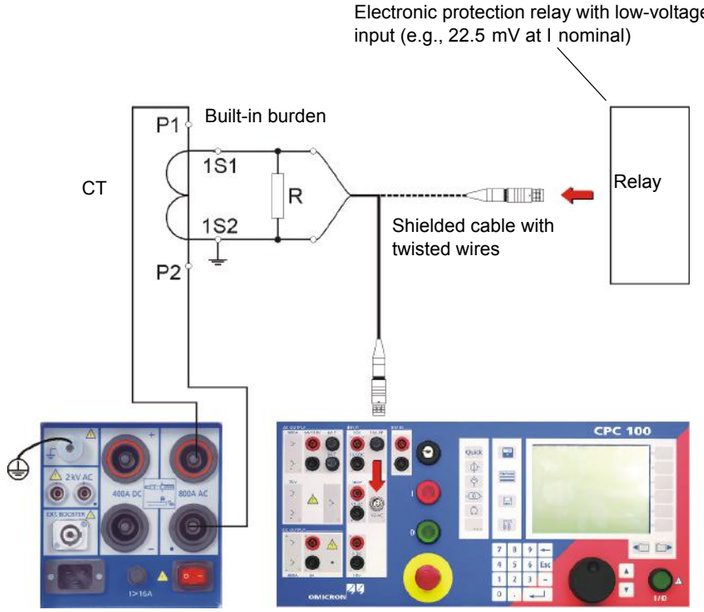
CTRogowski

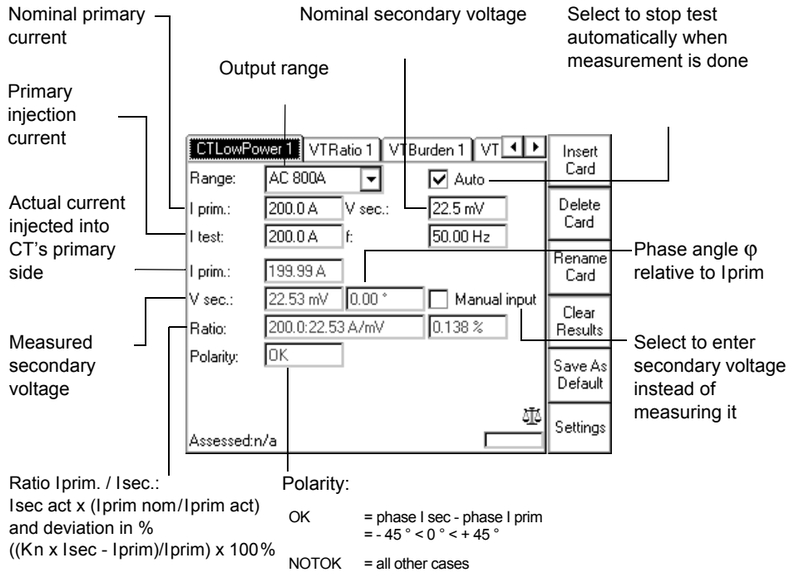


*) Note that the current **I sec** does not really exist in the system. It is a calculated current only.

CTLowPower (Ratio)

Use the **CTLow Power** test card to measure the ratio of a low-power current transformer with a built-in burden and an output voltage that is directly proportional to the primary current.





SV-Ratio

The **SV-Ratio** test card is mainly used to check the ratio between the output current or voltage and the input current or voltage of the selected merging unit channel according to the IEC 61850 standard. In addition, the **SV-Ratio** card is also used to determine the polarity of the signal, whereas the *CPC 100* serves as the signal source. The merging units generate the input voltages or currents.

The *CPC 100* test system performs closed-loop testing whereby a test signal is injected on the primary side of the current/voltage sensors. The Merging Unit (MU) converts the sensor output into an SV stream which is published to the substation network. The *CPC 100* then reads the data back from the network in order to perform a variety of different tests.

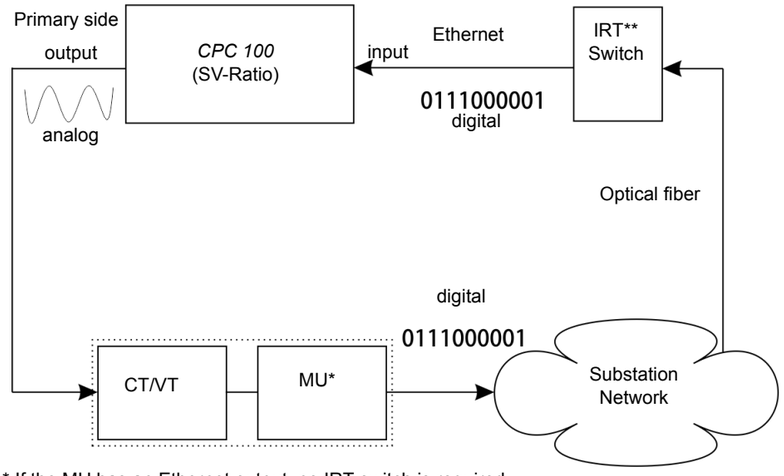
The *CPC 100* transforms the sampled points to the spectral function of the signal. This Fourier-transformed sampled values signal is filtered with a special Hann window to only retrieve the "signal" at the selected frequency. This allows frequency-selective measurements to be performed on SV streams and thereby the noise is suppressed.

The **SV-Ratio** test card can be accessed from **CT**, **VT** or **Others**.

The following tests can be performed:

- Ratio and polarity
- Automatic MU detection
- Frequency-selective current/voltage measurement
- Noise level measurement
- Magnitude response of the signal processing chain (15 to 400 Hz)

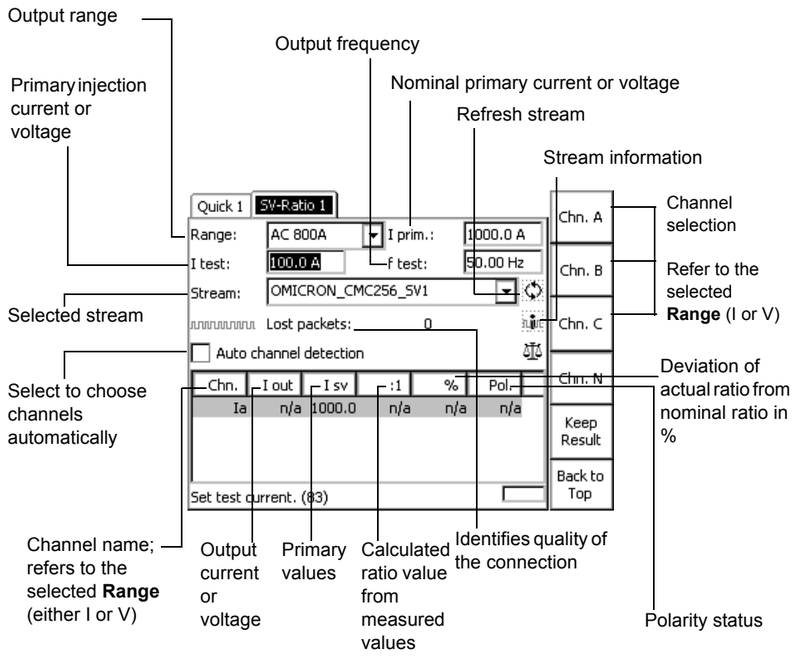
Block diagram of a typical measurement setup:

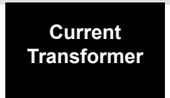


* If the MU has an Ethernet output, no IRT switch is required.

** IRT Switch: Industrial Real-Time Switch

Note: The **SV-Ratio** test card can be used both for current transformers and voltage transformers alike. Therefore, the description refers to currents and voltages.



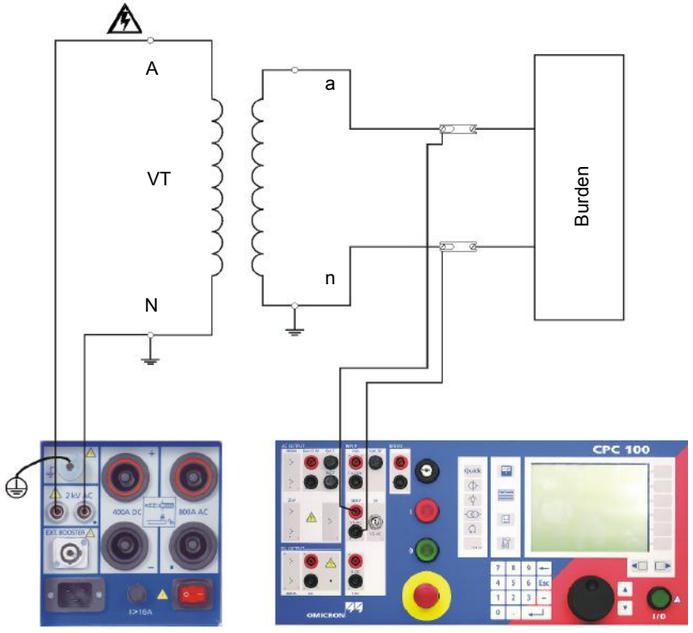

Current
Transformer

Voltage Transformer

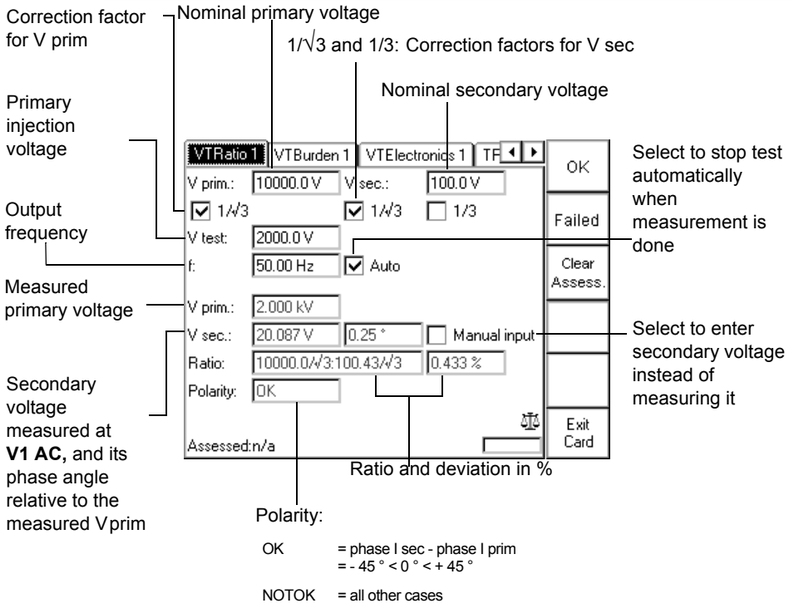
CPC 100 V 3.10

VTRatio

Use the **VTRatio** test card to measure a voltage transformer's ratio with injection on the VT's primary side with up to 2 kV from **AC OUTPUT**.



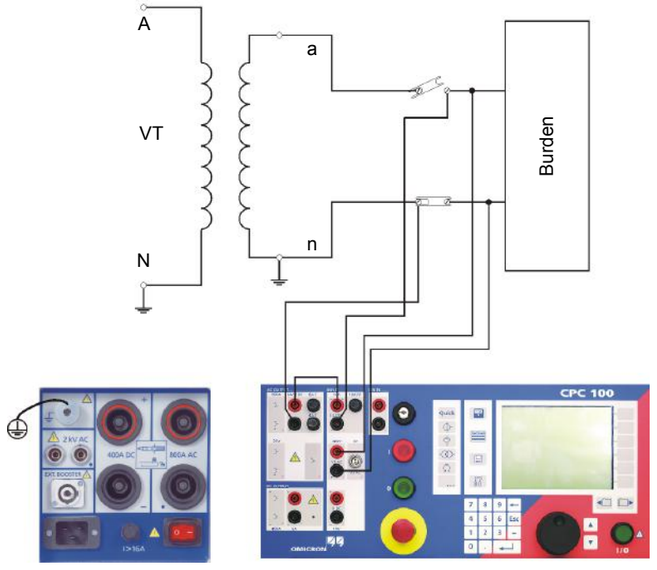
Warning: For VT ratio measurement, the *CPC 100* output has to be connected to the primary side of the VT. Connecting the *CPC 100* output to the secondary side of the VT will cause hazardous voltages on the primary side.



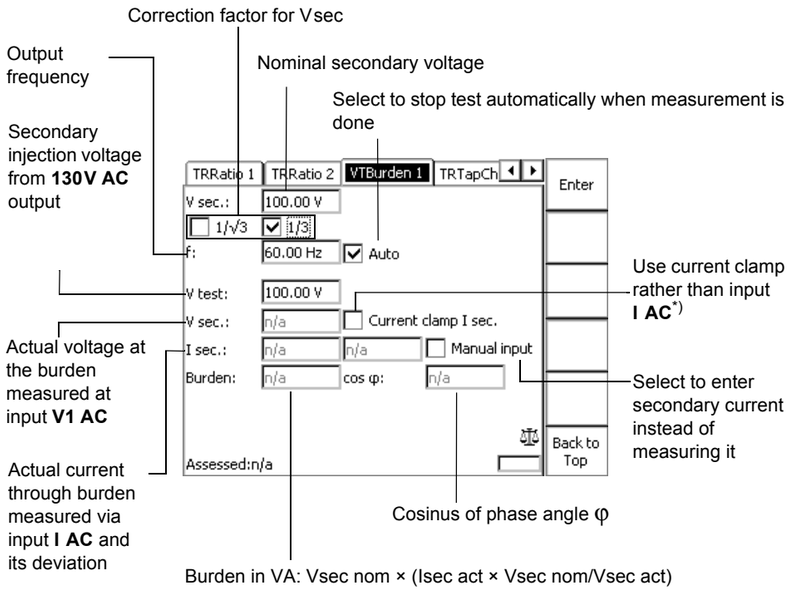
VTBurden

Use the **VTBurden** test card to measure a voltage transformer's secondary burden with voltage injection on the VT's secondary side with up to 130 V from **AC OUTPUT**.

To do so, open the circuit as shown in the figure below, and inject the AC voltage from the *CPC 100*'s **130V AC** output into the burden. Input **I AC** measures the current that flows into the burden, and input **V1 AC** the voltage at the burden.



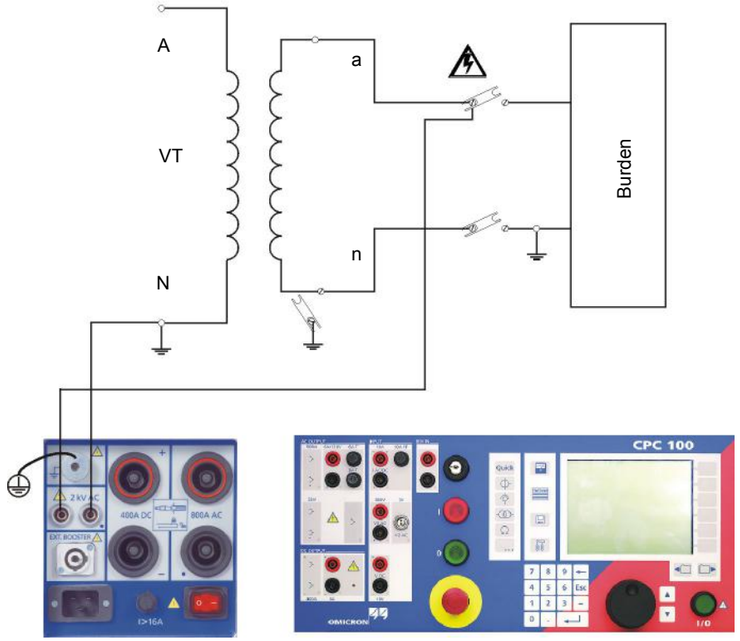
VTBurden



*) Due to cross-talk between the measuring inputs **V1 AC** and **V2 AC**, we suggest not to connect a current clamp to the input **V2 AC**. Therefore, use a current clamp with current output.

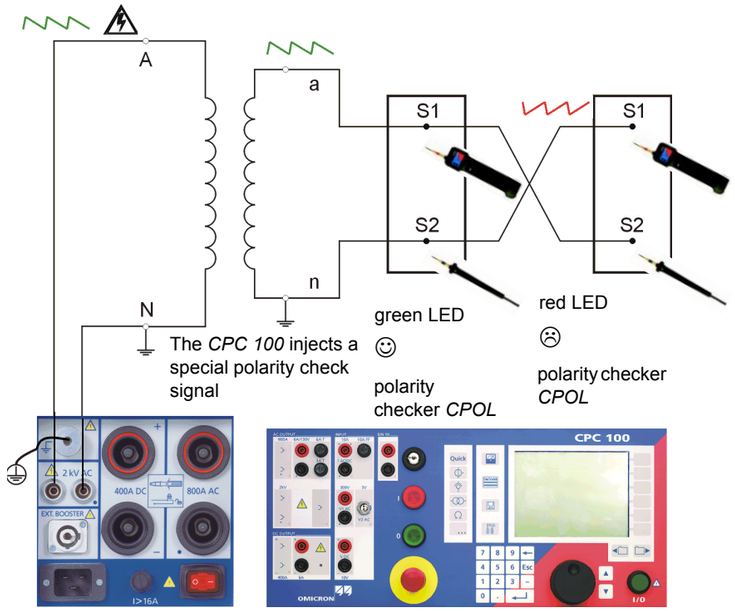
Voltage Withstand Test

This test is identical to the voltage withstand test described on page Current Transformer-4.



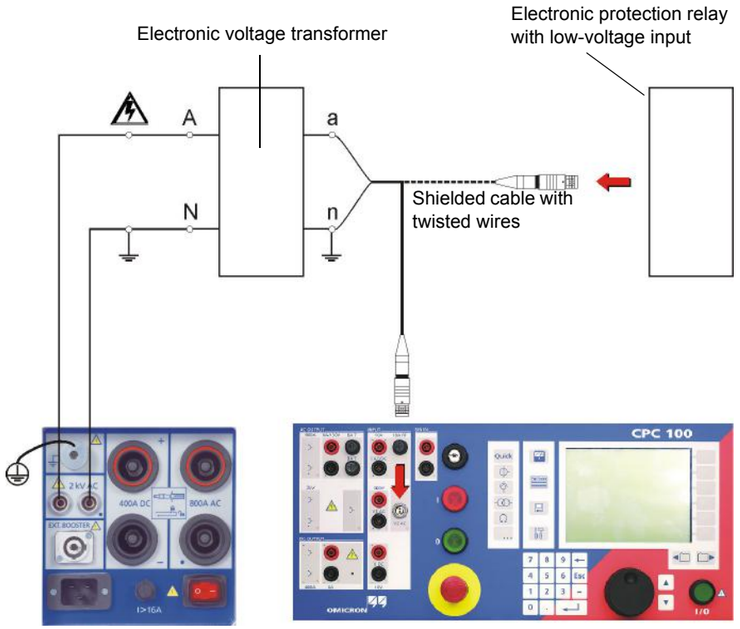
Polarity Check

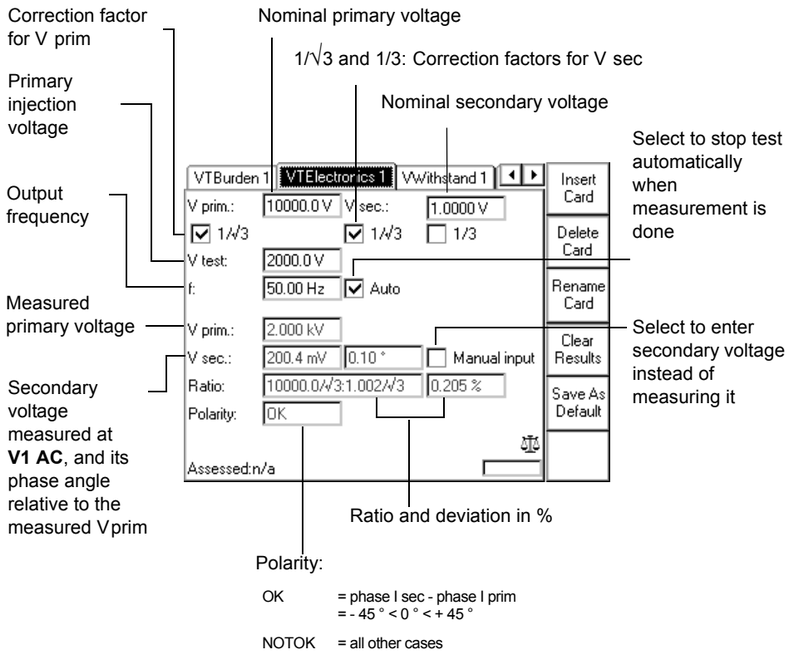
This test is identical to the polarity check described on page Current Transformer-5.



VTElectronics

Use the **VTElectronics** test card to test the ratio of non-conventional electronic voltage transformers with a very low-level secondary voltage.





Voltage Transformer - 4

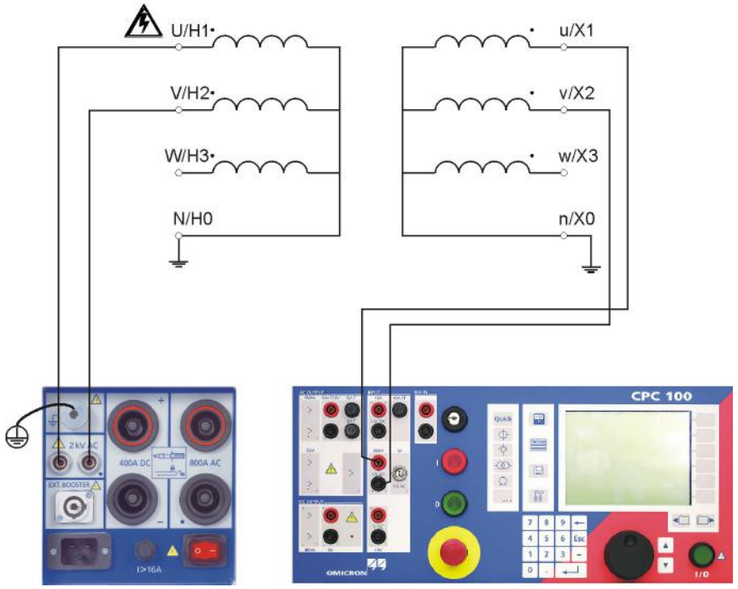
Transformer

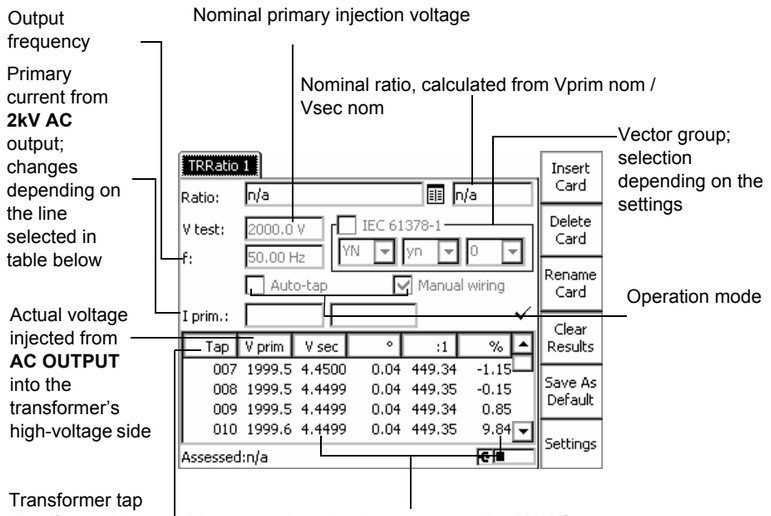
CPC 100 V 3.10

TRRatio (per Tap)

Use the **TRRatio** test card to measure a power transformer's ratio by injecting AC voltage with up to 2 kV from **AC OUTPUT** into the transformer's primary side (refer to the following figure).

Setup for testing a power transformer ratio: Yy0 transformer, primary and secondary side star connection.





V sec	Actual voltage measured at **V1 AC**
°	Phase angle of the primary current relative to Vprim nominal.
:1	Calculated ratio value from the measured values Vprim / Vsec
%	Deviation of the actual ratio from the nominal ratio

Settings Page

Pressing the **Settings** menu key opens the Settings page. The Settings page of the **TRRatio** test card has another functionality as on other test cards.

Note: The Settings page opens automatically if the **Auto-tap** operation mode is activated.

The Settings page allows adding the transformer's ratio per tap as follows. After pressing the **Add Tap** menu key first enter the Tap Number, V prim and V sec. Add the next tap by pressing the **Add Tap** menu key and enter the corresponding V prim and V sec values. After this, pressing the **Add Tap** menu key repeatedly adds more taps with a step calculated from the values of the preceeding taps. The tap entries apply equally to all phases. After adding all taps, press the **Main Page** menu key to transfer the data to the main page.

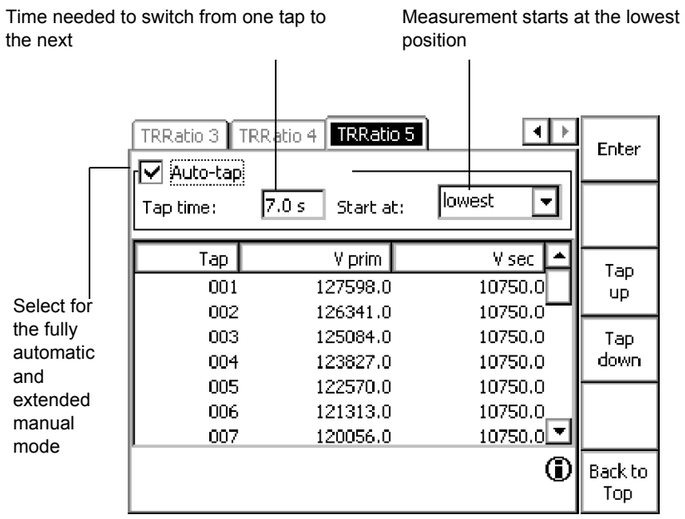
Use the **Automatic Tap Fill** function to automatically fill in the nominal ratio table of the **TRRatio** test card for symmetric tap changers.

Performing a TRRatio Test (per Tap)

While passing through the power transformer's tap changer positions, press **Keep Result** for each single position.

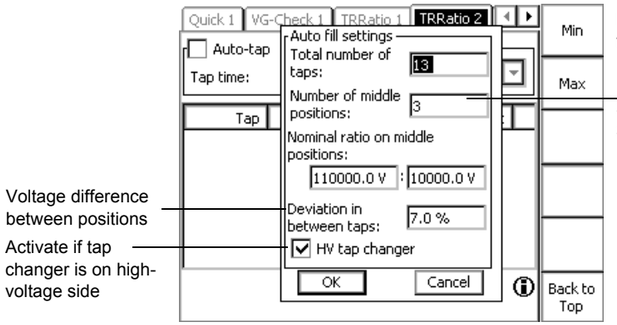
Note: This procedure is only required for manual wiring. Otherwise, the test runs fully automatically.

Settings Page



Automatic Tap Fill

The **Settings** page of the **TRRatio** test card offers an offline **Auto-tap** fill function. It automatically fills in the nominal ratio table of the **TRRatio** test card for symmetric tap changers.



The total number of taps minus the middle positions defines the number of taps above and below the middle position(s). To determine the voltage for each tap position, the nominal ratio of the middle position(s) and the deviation percentage are needed and the **HV tap changer** check box needs to be activated if applicable.

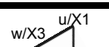
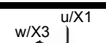
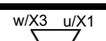
TRRatio (per Tap)

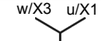
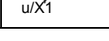
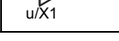
The following table shows the **V prim** and **V sec** settings on the **TRRatio** test card for different transformer's winding connections.

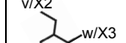
Note: The table is valid for manual wiring and in connection with the *CP SB1*.
In the Transformer high-voltage side column, + means that the terminals in the *CP SB1* are short circuited.

IEC 60076 vector group	Winding connection		Measurement	Transformer high-voltage side	Transformer low-voltage side	Measured turn ratio
	HV / H	LV /X				
Dd0			A	U-V / H1-H2	u-v / X1-X2	1
			B	V-W / H2-H3	v-w / X2-X3	
			C	W-U / H3-H1	w-u / X3-X1	
Yy0			A	U-V / H1-H2	u-v / X1-X2	1
			B	V-W / H2-H3	v-w / X2-X3	
			C	W-U / H3-H1	w-u / X3-X1	
Dz0			A	U-V / H1-H2	u-v / X1-X2	1
			B	V-W / H2-H3	v-w / X2-X3	
			C	W-U / H3-H1	w-u / X3-X1	

TRRatio (per Tap)

Dy5			A	U-(V+W) / H1-(H2+H3)	w-u / X3-X1	√3/2
			B	V-(U+W) / H2-(H1+H3)	u-v / X1-X2	
			C	W-(U+V) / H3-(H1+H2)	v-w / X2-X3	
Yd5			A	U-(V+W) / H1-(H2+H3)	w-u / X3-X1	√3/2
			B	V-(U+W) / H2-(H1+H3)	u-v / X1-X2	
			C	W-(U+V) / H3-(H1+H2)	v-w / X2-X3	
Yz5			A	U-(V+W) / H1-(H2+H3)	w-u / X3-X1	√3/2
			B	V-(U+W) / H2-(H1+H3)	u-v / X1-X2	
			C	W-(U+V) / H3-(H1+H2)	v-w / X2-X3	
Dd6			A	U-V / H1-H2	v-u / X2-X1	1
			B	V-W / H2-H3	w-v / X3-X2	
			C	W-U / H3-H1	u-w / X1-X3	

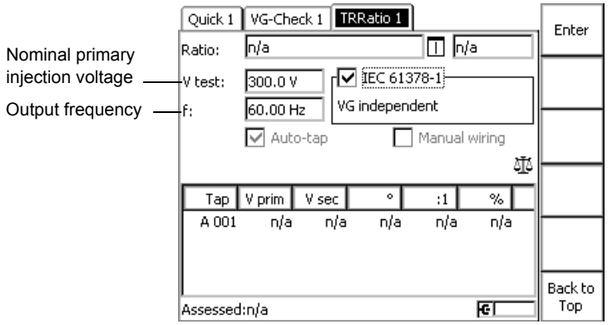
Yy6			A	U-V / H1-H2	v-u / X2-X1	1
			B	V-W / H2-H3	w-v / X3-X2	
			C	W-U / H3-H1	u-w / X1-X3	
Dz6			A	U-V / H1-H2	v-u / X2-X1	1
			B	V-W / H2-H3	w-v / X3-X2	
			C	W-U / H3-H1	u-w / X1-X3	
Dy11			A	U-(V+W) / H1-(H2+H3)	u-w / X1-X3	1*√3/2
			B	V-(U+W) / H2-(H1+H3)	v-u / X2-X1	
			C	W-(U+V) / H3-(H1+H2)	w-v / X3-X2	
Yd11			A	U-(V+W) / H1-(H2+H3)	u-w / X1-X3	1*√3/2
			B	V-(U+W) / H2-(H1+H3)	v-u / X2-X1	
			C	W-(U+V) / H3-(H1+H2)	w-v / X3-X2	

Yz11			A	U-(V+W) / H1-(H2+H3)	u-w / X1-X3	1*√3/2
			B	V-(U+W) / H2-(H1+H3)	v-u / X2-X1	
			C	W-(U+V) / H3-(H1+H2)	w-v / X3-X2	

TRRatio according to IEC 61378-1

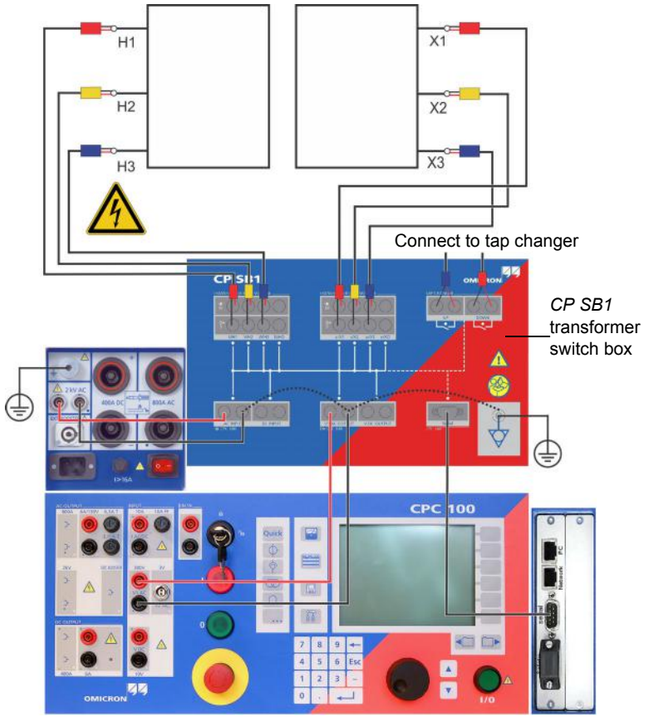
The IEC 61378-1 is a standard for testing transformers with unconventional vector groups. Activate the **IEC 61378-1** check box to perform a measurement according to this standard. The test is vector-group independent.

Note: The **IEC 61378-1** check box is only available if the *CP SB1* switch box is connected.



With the **IEC 61378-1** check box activated, the *CPC 100* carries out two standard-compliant measurements for each winding and calculates the transformer's turns ratio and phase shift. The measurement table displays the same values as for the standard **TRRatio** measurement. The magnetization current and phase angle will not be available in this mode.

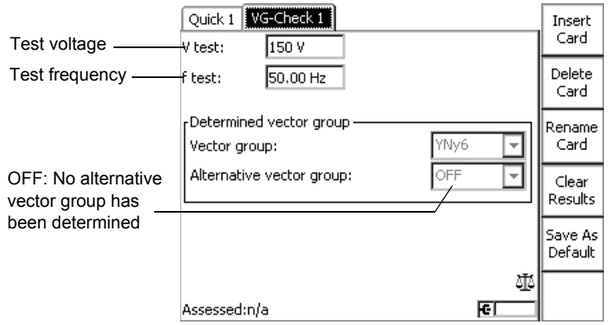
Note: The **IEC 61378-1** test takes longer than a standard ratio measurement.



Vector Group Check

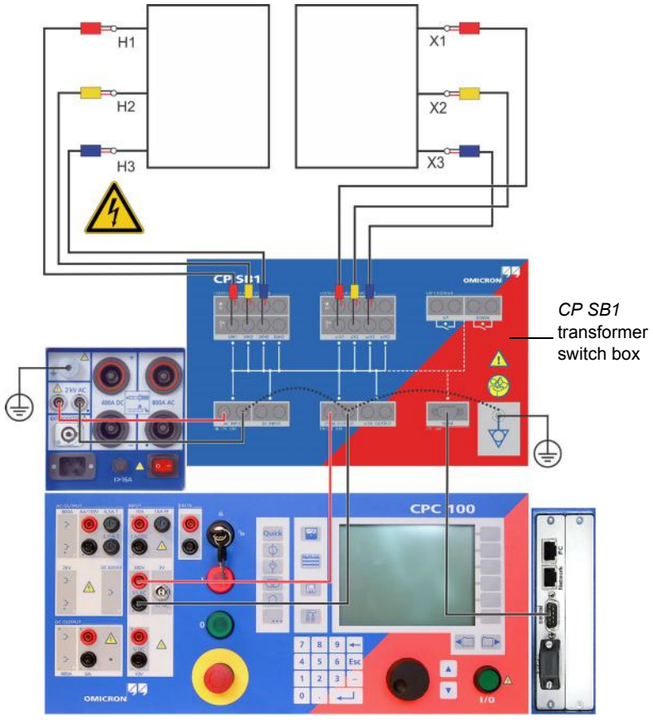
Use the **Vector Group Check** test card to automatically determine the transformer's vector group. To start the **Vector Group Check**, enter the test voltage and frequency in the **VG-Check** test card.

Note: The **Vector Group Check** test requires a *CP SB1* transformer switch box.



The *CPC 100* energizes the transformer's primary windings and measures the voltages on the secondary terminal. The optimized algorithm reduces the number of measurements. The vector group is determined according to the voltage distributions. In cases where the measurement results apply equally to two vector groups, an alternative group is provided.

Vector Group Check

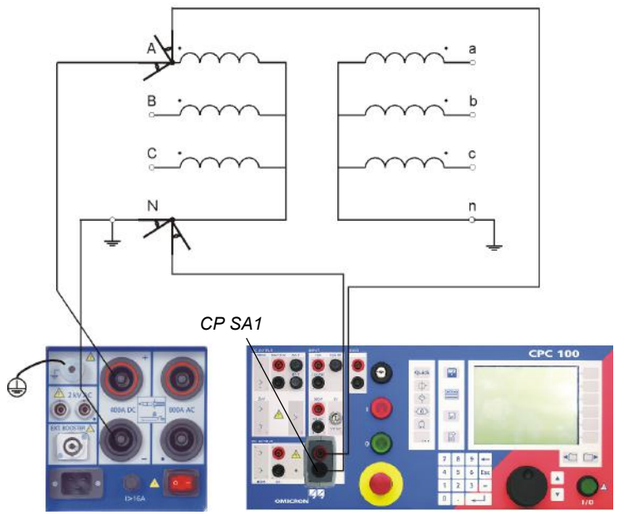


Winding Resistance

Use the **RWinding** test card to measure the resistance of a power transformer's winding as described on page Current Transformer-4.

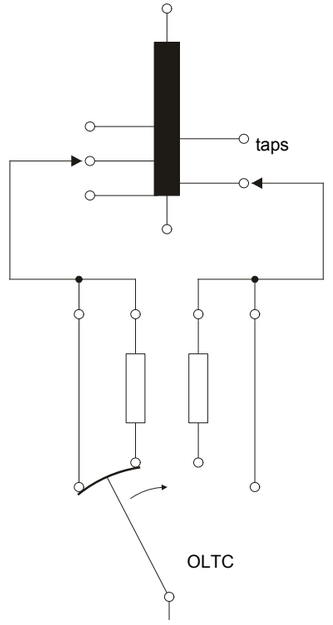
Alternatively, inject the current directly from the **400A DC** output as shown below.

Warning: Connect the *CP SA1* discharge box to the *CPC 100*'s **V DC** input sockets to protect yourself and the *CPC 100* from high-voltage hazards.



TRTapCheck (for OLTC)

Use the **TRTapCheck** test card to measure the winding resistance of the individual taps of a power transformer's tap changer, and to check whether the on-load tap changer (OLTC) switches without interruption.

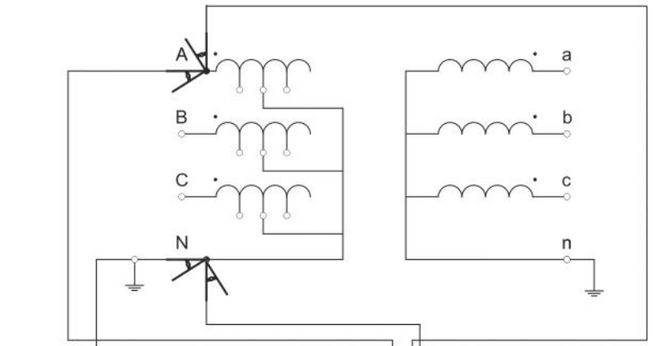


The *CPC 100* injects a constant current from the **6A DC** output into the power transformer and the current is led via the **I AC / DC** input for measurement. Alternatively, the current injected from the **400A DC** output is measured internally. From this current value and the voltage measured by the **V DC** input, the winding resistance is calculated.

In the moment the tap is changed, the **I AC / DC** measuring input detects the sudden, very short drop of the current flow. A properly working tap change differs from a malfunctioning one, e.g., an interruption during the change, by the magnitude of the ripple and slope values. An interruption will result in much higher ripple and slope values than a properly functioning tap change.

The ripple and slope values are indicated at the **TRTapCheck** test card's measurement table.

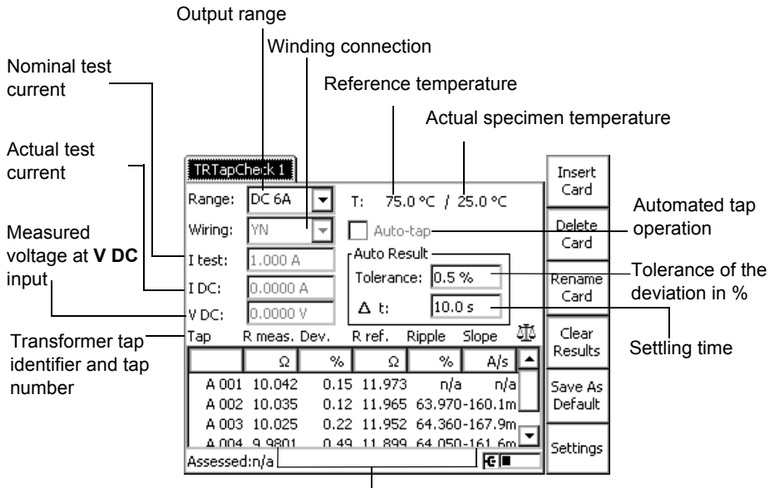
TRTapCheck (for OLTC)



CP SA1

Note: It is recommended to use the *CP SA1* for this test.

Warning: Never open the measuring circuit while current flows. Dangerous voltage may occur.



Rmeas: Actual resistance

Dev.: Deviation in % between the maximum and the minimum measured values evaluated with the settling time.

R ref.: Temperature-corrected resistance value

Ripple: Samples and holds the biggest measured current ripple that occurred in the measuring cycle. It is indicated in % with reference to I DC.

Slope Samples and holds the biggest measured steepness of the falling edge of the actual test current.

Tap Changer Test and Measuring the Winding Resistance

When testing a tap changer, we recommend:

- To inject the same current value for each phase.
- To perform tests of each phase, start with the lowest tap through to the highest and continue backwards down to the lowest tap again. Taps may show quite different results depending on the direction of the tap movement and defects can behave differently. An interruption caused by a defective tap changer results in comparatively high measured values for ripple and slope.

Example: Results of a tap changer and winding resistance test

For the tap changer test, the last two columns of the table are relevant.

Tap	R meas.	Dev.	R ref.	Ripple	Slope
	Ω	%	Ω	%	A/s
001	764m	0.05	913.0m	85.00	-50.50m
002	764m	0.05	913.0m	0.00	-15.57m
003	810m	10.7	974.0m	0.50	-31.44m
004	768m	0.05	917.7m	0.00	-13.04m
005	815m	9.70	974.0m	0.60	-30.27m
006	772m	0.04	922.0m	0.00	-12.35m
007	916m	9.74	1.01	20.00	-450.85m

High ripple because inductance is charged

Values okay because always in the same range

Tap defective: significantly higher values for ripple and slope. Compared to the properly functioning tap change of line 5, for the defective tap in line 7 the ripple is about 30 times and the slope about 15 times higher.

TRTapCheck (for OLTC)

Auto Keep Result

After pressing the **Auto Keep Result** menu key, the *CPC 100* waits until stable results with a deviation less than the defined tolerance (in %) within the defined settling time (Δt) are achieved. After then, a new result line is added and the next measurement starts.

Note: If the *CPC 100* is in **Auto Keep Result** status, the user can end the process by either pressing **Keep Result** or by changing to the Tolerance setting and changing the value. The soft key **Set Current Deviation** resumes the value of the current deviation in the **Tolerance** field.

Performing a Tap Changer Test

1. Press the I/O (test start/stop) push-button to start the test.
2. Press **Keep Result** to save the resistance value of this tap or press **Auto Keep Result**. In this case, the *CPC 100* waits until stable results within the set **Tolerance** and Δt are achieved. After then, a new result line is added showing the number of the next measured tap.
3. Move to the next position on the tap changer.
4. Repeat steps 2 and 3 for all taps you want to measure.

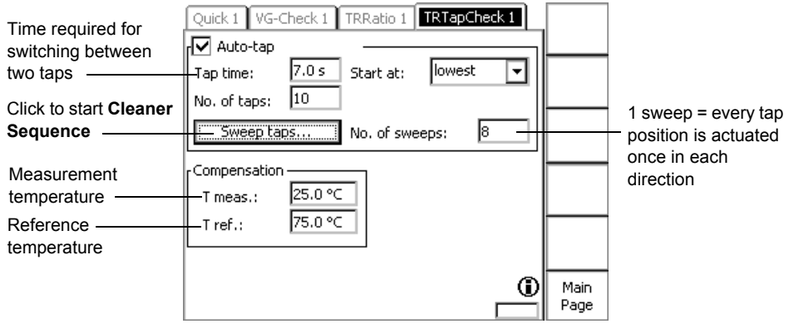
5. Press the I/O (test start/stop) push-button to stop the test and wait until the transformer windings are discharged.

Warning: Before disconnecting the transformer under test, ground all transformer connections.

Tap Changer Cleaner Sequence

The **Tap Changer Cleaner Sequence** is used to sweep all taps before performing a **Winding Resistance** measurement to ensure that the taps are clean.

Note: The **Tap Changer Cleaner Sequence** can only be activated if the *CP SB1* transformer switch box is connected and **Auto-tap** is selected.

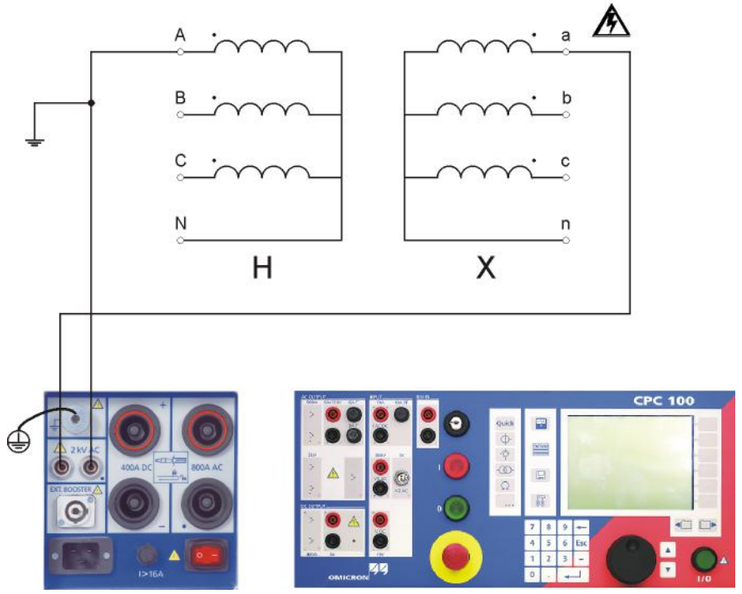


The currently sweeped tap and the remaining time are displayed during the sequence.

Note: You can only interrupt the **Tap Changer Cleaner Sequence** by pressing the Emergency Stop button.

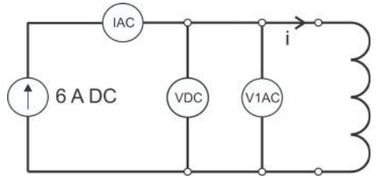
Voltage Withstand Test

This test is identical to the voltage withstand test described on page Current Transformer-4.



Demagnetization

Use the **Demag** test card to demagnetize the transformer core. Magnetized transformers may easily saturate and draw an excessive inrush current upon energization. Since the forces on the windings due to high inrush current may cause damage or even breakdown, it is desirable to avoid them.

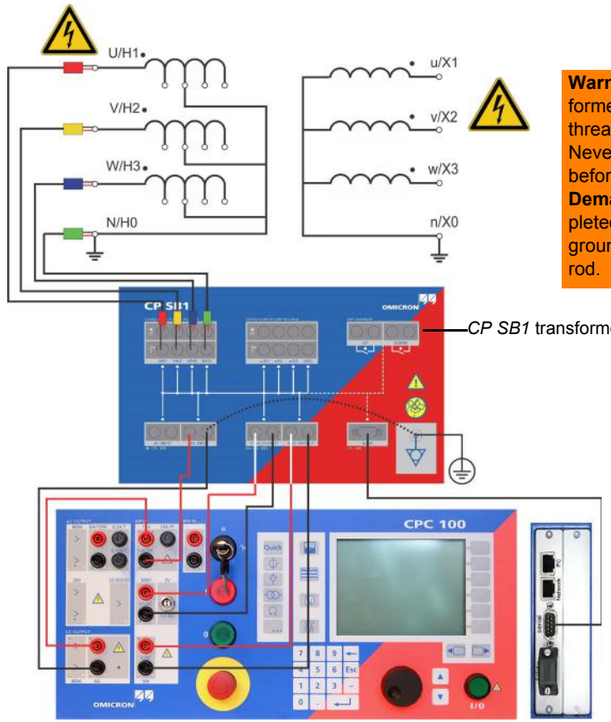


The *CPC 100* **Demag** test card requires a *CP SB1* transformer switch box. The wiring is the same as for a standard resistance test plus a connection of the **V1** input to the switch box. Via the switch box, the *CPC 100* injects a constant current from the **6A DC** output into the power transformer. The current is led through the **I AC / DC** input for measurement.

In the **Demag** test card you need to:

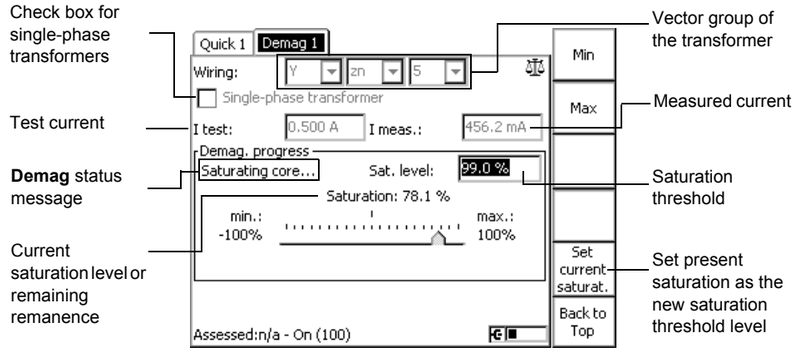
- enter the vector group of the transformer,
- specify whether the test object is a single-phase transformer, and
- enter the test current.

In the first step during the demagnetization process, the transformer core is saturated. This process stops at predefined thresholds. If a threshold is not reached over a long period of time, the saturation level can be adapted manually. By pressing the **Set current saturat.** soft key, the present saturation level can be set as the new threshold. During the **Demag** cycle, the initial remanence is measured and the currently remaining remanence is constantly displayed. After the test, the core is demagnetized.



CP SB1 transformer switch box

Warning: The transformer can carry life-threatening currents. Never touch the cables before the automatic **Demag** cycle is completed. If in doubt, use a grounding or discharging rod.



Test card during **Demag** process

Demag status messages:

Wiring check...	Checking for correct wiring
Idle.	Displayed before the process is started
Test was canceled.	Displayed after pushing the Emergency Stop button or confirming an error message
Saturating core...	Core is being saturated
Discharging...	Core is being discharged
Demagnetizing...	Actual demagnetization cycle in progress
Core is demagnetized.	**Demag** cycle has been successful

Resistance

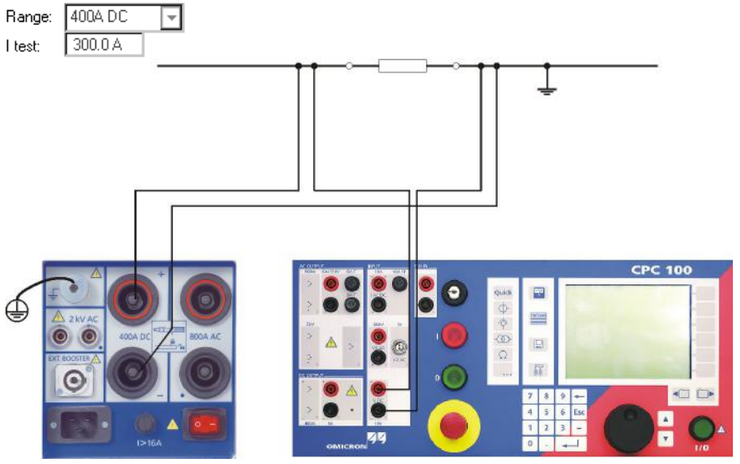
CPC 100 V 3.10

µΩ Measurement

The **Resistance** test card provides a total of three output ranges. The test setup depends on the selected range.

1 µΩ to 10 mΩ

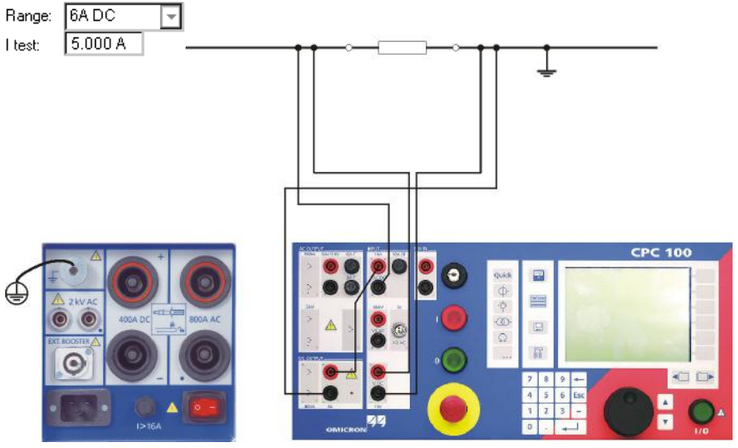
Setup for a µΩ measurement in the 400A DC range:



Inject current from the **400A DC** output to both sides of the test object. Input **V DC** measures the voltage drop, the software calculates the test object's resistance.

10 mΩ to 10 Ω

Setup for a mΩ measurement in the 6A DC range:

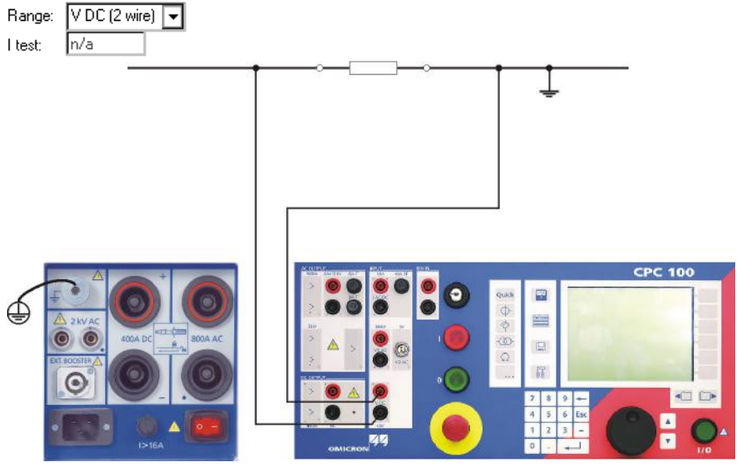


Inject current from the **6A DC** output to both sides of the test object. To measure this current, route it via the **I AC/DC** input as shown in the figure above. Input **V DC** measures the voltage drop, the software calculates the test object's resistance.

Warning: Do not measure on a large inductance in this mode. Use **RWinding** instead.

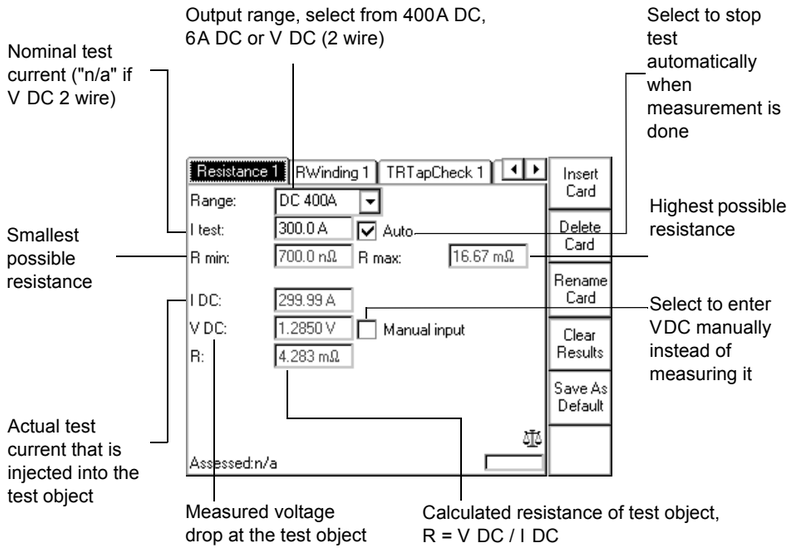
10 Ω to 20 kΩ

Setup for an Ω to kΩ measurement in the V DC (2 wire) range:



At this range, the DC input **V DC** outputs the current needed to measure the resistance.

µΩ Measurement



Winding Resistance

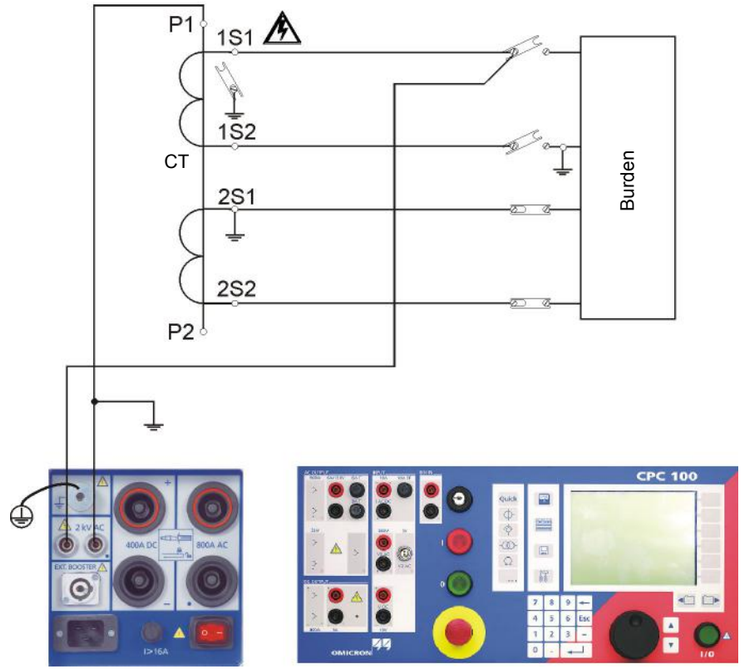
Use the **RWinding** test card to measure the resistance of a current transformer's secondary winding as described on page Current Transformer-4.

Alternatively, inject the current directly from the **400A DC** output.

Warning: Connect the *CP SA1* discharge box to the *CPC 100*'s **V DC** input sockets to protect yourself and the *CPC 100* from high-voltage hazards.

Voltage Withstand Test

This test is identical to the voltage withstand test described on page Current Transformer-4.

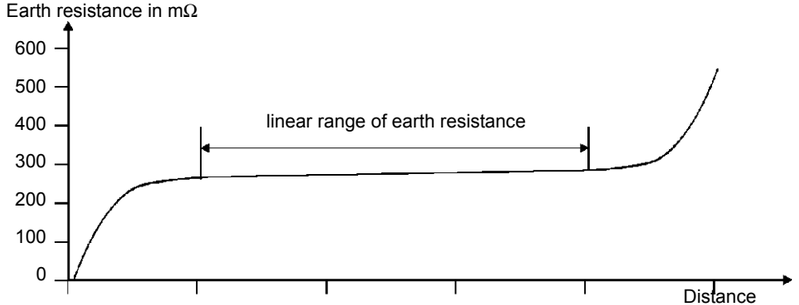


RGround

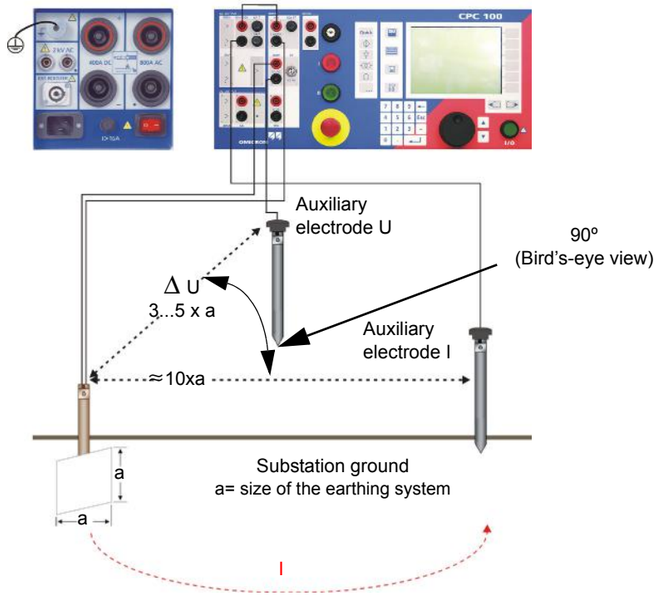
Use the **RGround** test card to determine earth resistance between a substation's ground system and a remote auxiliary electrode. To measure the earth resistance, the *CPC 100* injects AC current between the substation's ground system and a temporary remote auxiliary electrode. A second auxiliary electrode is used to measure the voltage potential across the substation's earth resistance.

Note: Make sure not to position the auxiliary electrode U too close to the substation's ground system. If you do so, you measure in a range where the earth resistance may not be linear (see figure below).
We suggest to test several points using a longer distance to the substation ground. That way you get a better understanding of where the linear range of the earth resistance lies, and where the measurements are reliable.

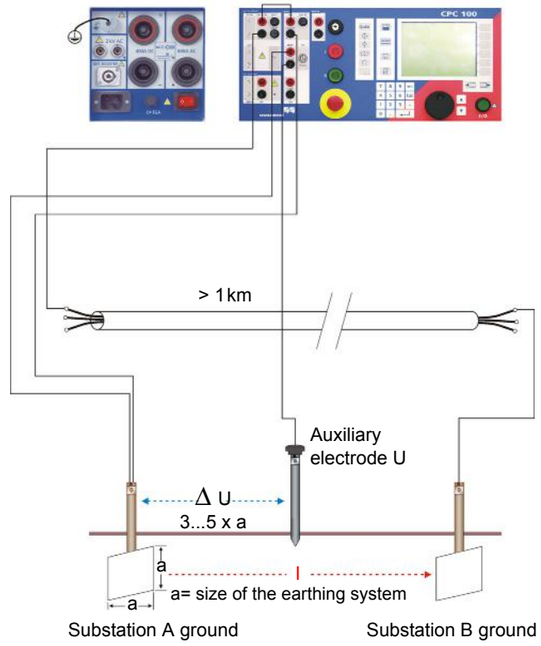
Theoretical resistance characteristic of an earth electrode:



Measuring the Ground Resistance of Small Ground Systems

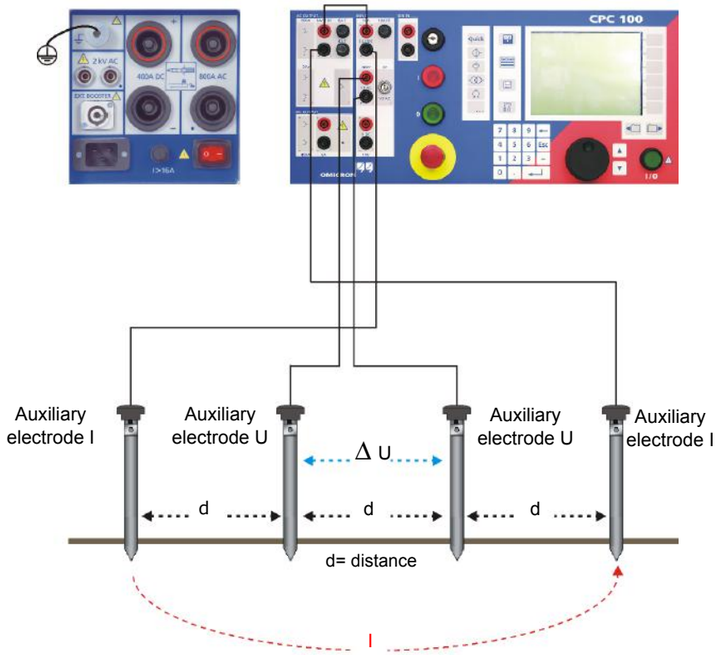


Measuring the Ground Resistance of Large Ground Systems



RGround

Measuring the Soil Resistivity



Calculating the soil resistivity:

$$\rho = 2 \pi d R$$

Legend:

ρ = soil resistivity

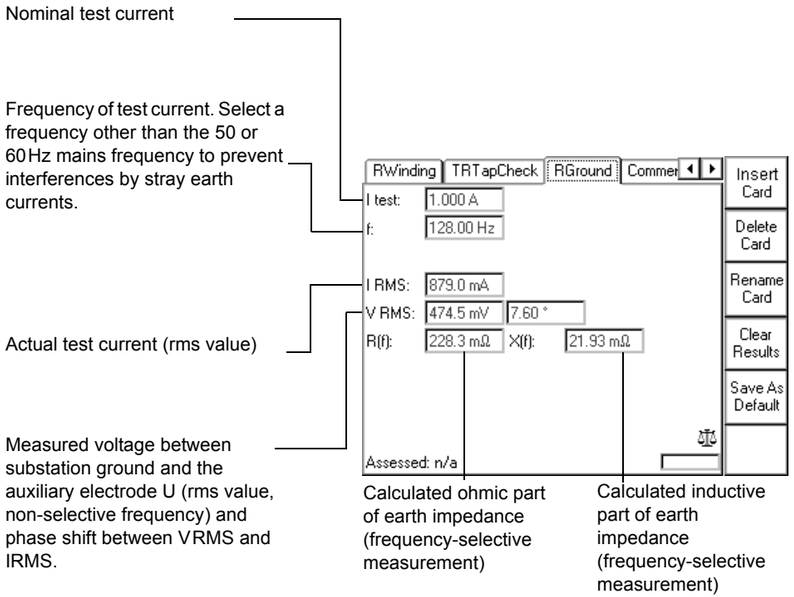
d = distance between auxiliary electrodes (identical between all electrodes)

R = calculated resistance as indicated at the **RGround** test card (R(f))

With the spacing of "d", the test measures the average soil resistivity between the U auxiliary electrodes down to a depth of "d". Therefore, varying "d" also varies the depth of the volume for which the soil resistivity is to be measured.

Caution: The **6A AC** output can carry a life-threatening voltage level at high loop impedances or open measuring circuits.

Note: To learn how to measure the resistance of a single ground rod in an earthing system, refer to the CPC 100 Reference Manual, section "RGround" of chapter "Resistance". The CPC 100 Reference Manual is available in PDF format on the *CPC 100 Toolsets* or the *CPC 100 Start Page*.



Others: Sequencer

CPC 100 V 3.10

General

Use the **Sequencer** test card to define a sequence of states to be applied to a connected test object. A sequence of up to 7 states can be defined. The states within that sequence execute sequentially. For each state, a trigger signal can be specified to prematurely terminate this state and execute the next one.

A sequence of states can either be executed once from state 1 to state x, or repeated continuously. Furthermore, the complete sequence can prematurely be terminated if during the execution of one of its states this state's specified trigger condition occurs.

Switch **o**ff **o**n **t**rigger, i.e., abort sequence when the trigger condition becomes true

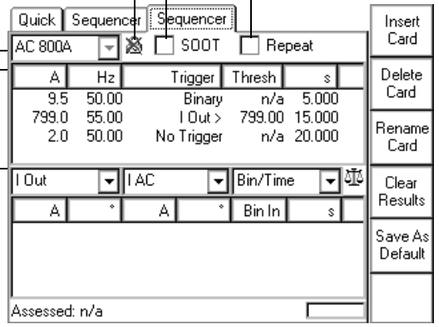
Synchronize with **V1 AC** (needs up to 200 ms to synchronize)

The sequence is repeated endlessly.***)

Output range selection

States table (state-specific settings):

- output quantity settings
- trigger specification*)
- duration of state if no trigger occurs**)



*) Note that some of the trigger events offered in the **trigger event** combo box depend on the measured quantity settings below (trigger on measurement).

Trigger on "Overload": the occurrence or the clearing of an output overload condition (clearing is delayed by 100 ms to debounce).

**) Setting a time of 0.000 s makes the state infinite. Only a trigger signal will terminate it.

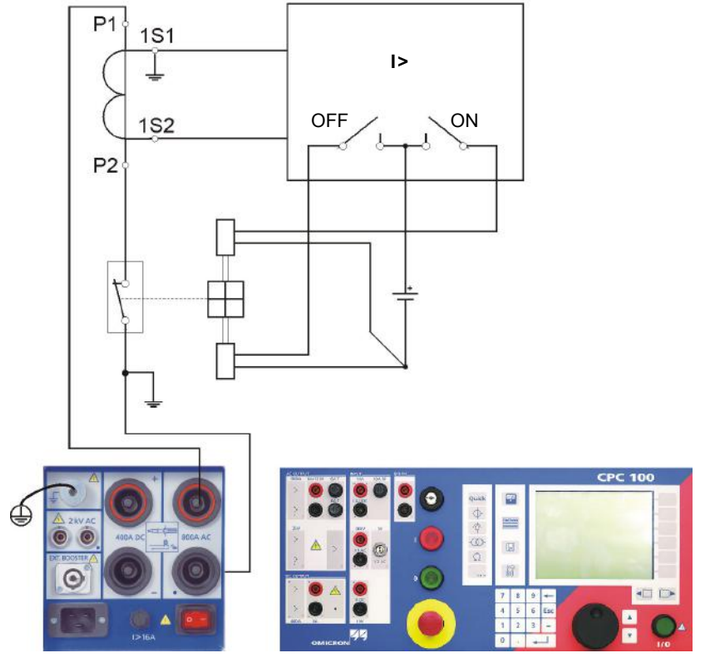
***) This option can lead to a freeze of the *CPC 100* caused by a memory overflow. This can happen if there are too much results in a certain time. In this case, the *CPC 100* can only be switched off via the Emergency Stop button. The *CPC 100* will work properly again after rebooting the device.

The feature **Manual Trigger** provides a possibility to manually initiate a trigger signal (i.e., a premature termination) of the current state at any time. This manual trigger has the same function as an automatic trigger signal.

Press the **Add State** button to define additional states. Note that the maximum possible number of states is 6.

Testing an Overcurrent Relay with an ARC Function

This sequence of four states tests a complete autoreclosure cycle with both a short dead time (rapid autoreclosure) and a long dead time (slow autoreclosure).



Testing an Overcurrent Relay with an ARC Function

State 1: "wait for the CB to open"

Set to output 400A until the trigger condition "Overload" occurs.

Here, trigger condition "Overload" means: The *CPC 100* cannot provide the 400A any longer because of the opening CB contact. Therefore, the opening CB contact terminates state 1.

The measurement table shows for state 1 that the relay time + the CB opening time lasted **290 ms**.

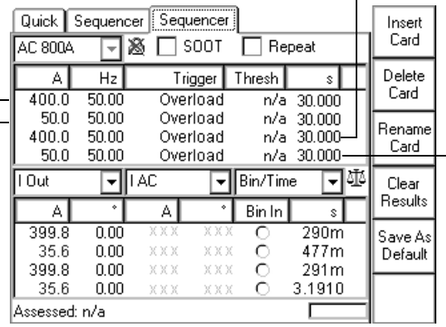
State 2: "wait for the CB to close"

Short dead time. Set to output 50A until the "Overload" trigger condition that started state 2 clears.

The measurement table shows for state 2 that the short dead time + the CB closing time lasted 477 ms. This time also includes the additional time to compensate for the debounce (see note).

The actual value for CB close equals 477 ms - 100 ms = **377 ms**.

Note that the r.m.s. measurement of IOut reacts slow and therefore the measurement table does not show the full current.



State 3: "wait for the CB to open"

Like state 1, see previous figure.

State 4: "wait for the CB to close"

Long dead time. Set to output 50A*) until the "Overload" trigger condition that started state 4 clears.

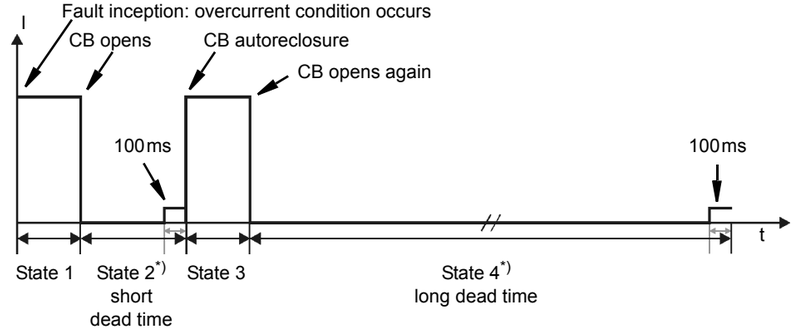
The measurement table shows for state 4 that the long dead time + the CB closing time lasted 3.191 s. This time also includes the additional time to compensate for the debounce (see note).

The actual value for CB close equals 3.191 s - 100 ms = **3.091 s**.

*) Current values < 50A do not initiate an "Overload" when the current circuit opens. For this reason, a nominal current value of 50A was chosen here, even though the CB is open.

Note: For debouncing purposes, at CB closing time measurements, the *CPC 100* adds a fixed time of 100 ms to the measured value. In order to determine the true CB closing time value, these 100 ms need to be deducted from the value displayed in the measurement table.

Time sequence of the four states to test the autoreclosure cycle



*) State 2 and 4 incl. the additional 100 ms the *CPC 100* adds to compensate for the debounce (see note above).

Others: Ramping

CPC 100 V 3.10

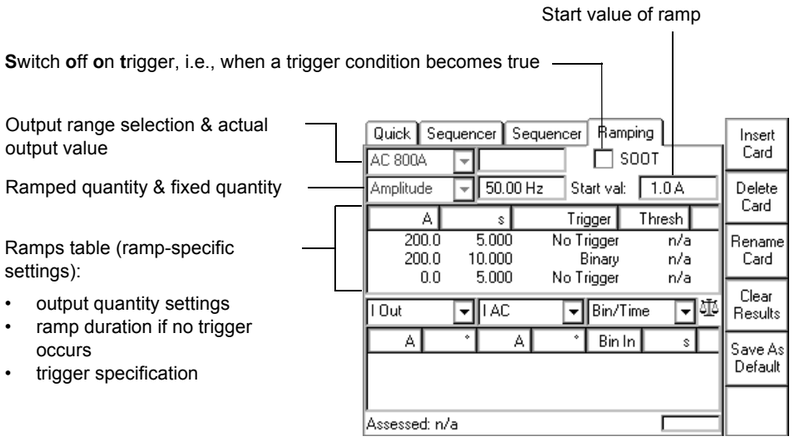
General

Use the **Ramping** test card to define a series of ramps to be applied to a connected test object.

A series of up to 5 ramps can be defined. The ramps within that series execute sequentially, and run from a start to an end value within a set period of time.

It is possible to specify a trigger signal that prematurely terminates either

- the entire series of ramps
- or the actual ramp only, and then continues with the next one (if any).



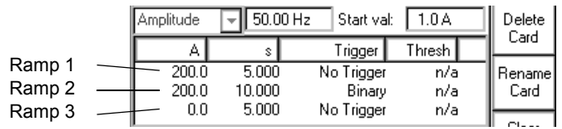
Manual Trigger

The feature **Manual Trigger** provides a possibility to manually initiate a trigger signal (i.e., a premature termination) of the current ramp at any time. This manual trigger has the same function as an automatic trigger signal.

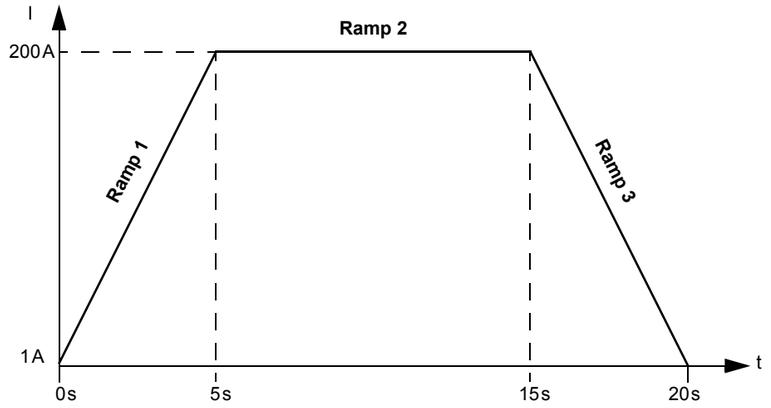
Add Ramp

Press the **Add Ramp** button to define additional ramps. Note that the maximum possible number of ramps is 5.

Example of a series of ramps



The three ramps defined in the ramps table shown above result in an output signal like this:



Ramp 1

- from 1 A
  (set at "Start val:")
- to end value 200 A
  (set in line 1 column "A")
- in 5 s
  (set in line 1 column "s")

Ramp 2

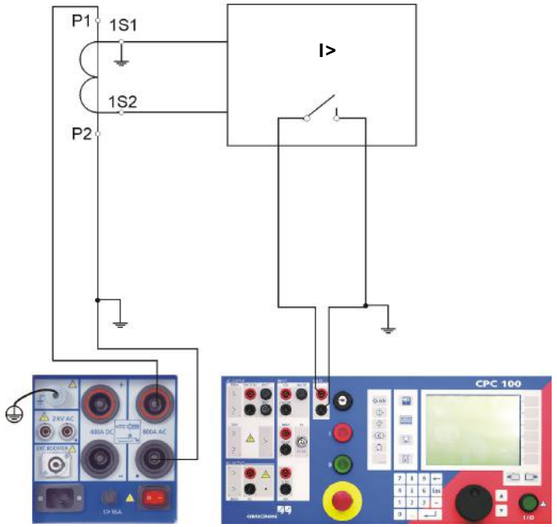
- from 200 A
  (end value of ramp 1)
- to end value 200 A
  (set in line 2 column "A")
- for 10 seconds
  (set in line 2 column "s")

Ramp 3

- from 200 A
  (end value of ramp 2)
- to end value 0 A
  (set in line 3 column "A")
- in 5 seconds
  (set in line 3 column "s")

Testing Pick Up / Drop Off Value of an Overcurrent Relay

To determine the pick up and the drop off value of a relay, a series of three ramps is defined. The first ramp determines the pick up value, the second one represents a 1 s pause time, and the third ramp determines the drop off value.



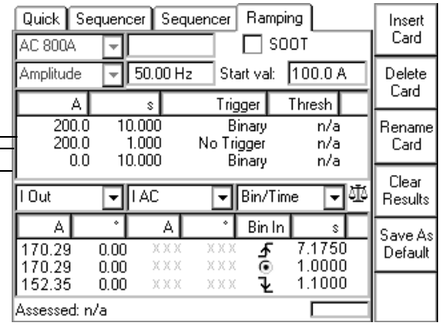
The *CPC 100*'s **AC OUTPUT** feeds the ramped current signal into a CT, which is connected to an overcurrent relay. The overcurrent relay's trip contact is fed into the *CPC 100*'s binary input **BinIn**, and acts there as a trigger signal.

Ramp 1:

Set to output a ramped current signal from 100.0A to either 200.0A in 10s, or until the trigger condition "Binary" occurs.

Here, trigger condition "Binary" means: the relay contact picks up. In this moment, ramp 1 terminates and the series continues with ramp 2.

The measurement table shows for ramp 1 that the relay contact picked up after 7.175s at a current value of 170.29A



Ramp 2:

Pause time. Test current output is "frozen" for 1 s.

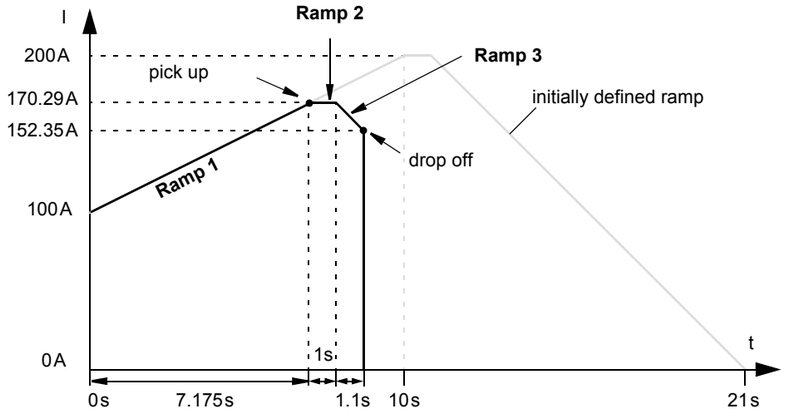
Ramp 3:

Because ramp 1 did not reach the 200A due to the trigger signal, ramp 3 starts with 170.29A, and then ramps down to zero with the set steepness (200.0A to 0.0A in 10s) until the trigger condition "Binary" occurs.

Here, trigger condition "Binary" means: the relay contact drops off. Since there are no further ramps defined, in this moment the sequence terminates.

The measurement table shows for ramp 3 that the relay contact dropped off 1.1s after ramp 3 started at a current value of 152.35A.

Time sequence of the three ramps:



Others: Amplifier

CPC 100 V 3.10

General

Use the **Amplifier** test card to set the *CPC 100* to an "amplifier-like" mode. In this mode, an input signal fed into a synchronization input drives the high-current output's magnitude, frequency and phase angle.

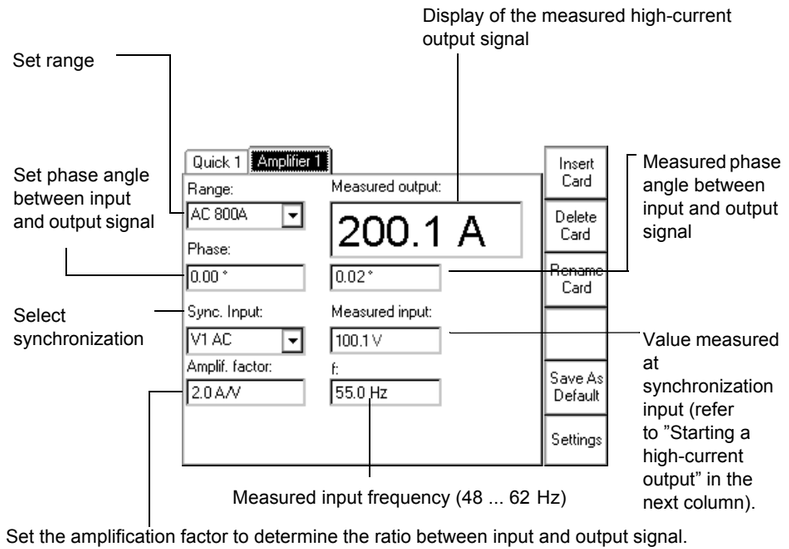
Select between **I AC**, **V1 AC** and **V2 AC** as synchronization inputs.

To prevent saturation, the output signal follows sudden magnitude changes at the synchronization input slowly. This smoothening effect delays the follow-up of the output current up to 250 ms.

Both the "amplification" factor and the phase angle between input and output are set by the user in the **Amplifier** test card.

Note: Changes in frequency and phase angle may result in unwanted effects. Both frequency and phase must be held stable.

Note: The input frequency is limited to a range of 48 ... 62 Hz.



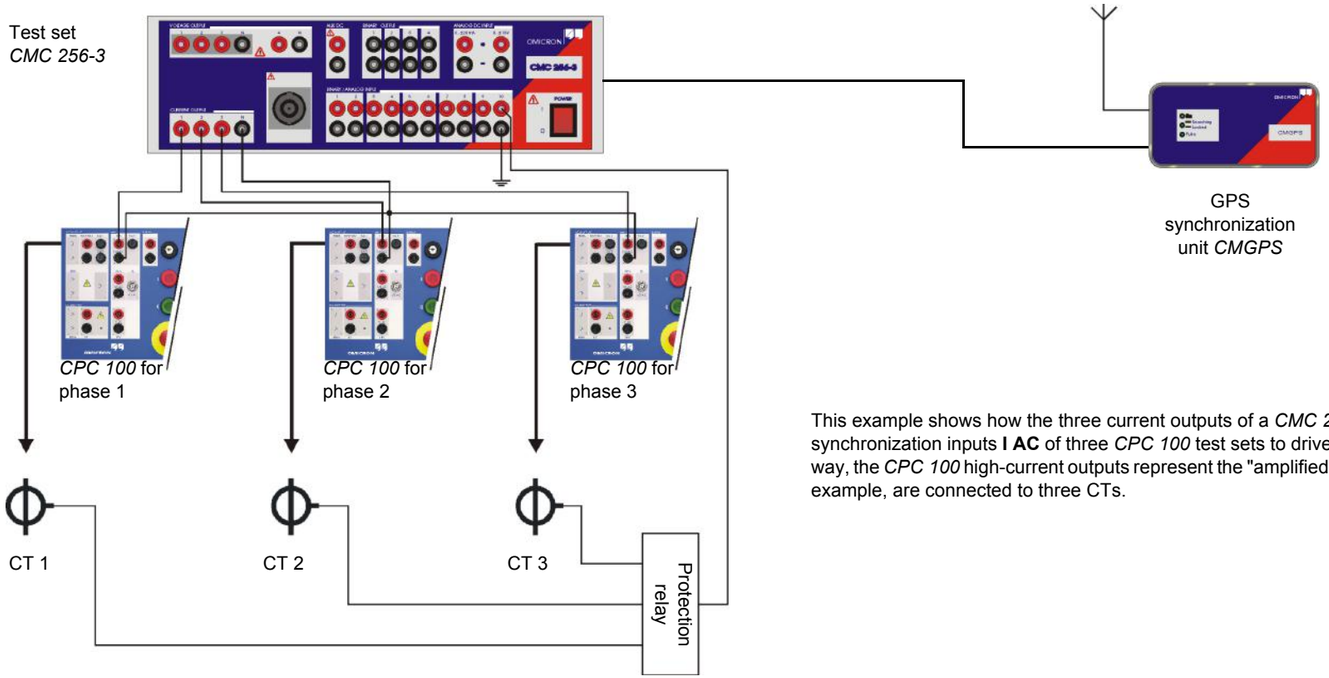
Note: The synchronization input is not automatically range-switching, it is fixed to its maximum value.

Starting a high-current output

Caution: Depending on the measured input signal, setting the amplification factor can result in unintentionally high currents. If the magnitude of the input signal is unknown or uncertain, it is strongly recommended to set the amplification factor to "0" before starting the test.

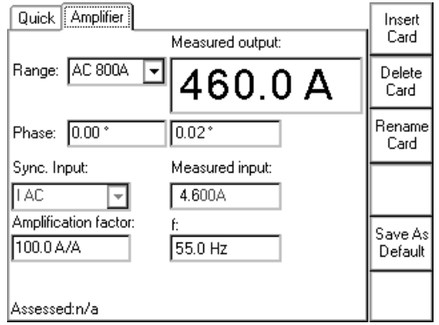
- Set an amplification factor of "0".
- Press I/O (test start / stop) to start the measurement.
  Now the display field shows the measured input value.
- With the measured input value in mind, enter the amplification factor now.
- Acknowledge this entry by pressing the handwheel or the Enter key to start the output.

Amplifier Use Case: GPS-Synchronized 3-Phase System for End-To-End Testing



This example shows how the three current outputs of a *CMC 256-3* test set are led to the synchronization inputs **I AC** of three *CPC 100* test sets to drive their high-current outputs. This way, the *CPC 100* high-current outputs represent the "amplified" *CMC 256-3* outputs and, in this example, are connected to three CTs.

Settings of **Amplifier** test card for this example use case:

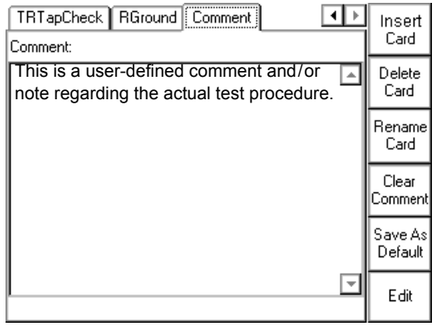


Others: Amplifier

Others: Comment

Starting the String Editor

The **Comment** card is inserted to a test procedure in the same manner like a test card. Its purpose is to hold a user-defined comment and / or note regarding the actual test procedure or other important information, such as operational data of a transformer, for example.



Press the context-dependent menu key **Edit** to start the *String Editor*, the tool for entering text.

When used for the **Comment** card, the *String Editor* differentiates between the input modes "Form Editor" and "Text Editor". After pressing **Edit**, "Text Editor" is active. With the exception of the context-sensitive key to switch between these two modes, the user interface is identical.

To create "flowing" text with no tabs in it, either input mode can be used. Compose a text of your choice by selecting the individual characters and symbols needed one by one and confirm them by pressing the handwheel. When finished, acknowledge with **OK**.

Form Editor - Text Editor

To create such a "2 columns" layout use the Form Editor.

Sub.:	Buers
Trans.:	TR24
Manuf.:	Siemens
Type:	KFRM 1863A / 22E
Year:	1955
Se. No.:	T-54953
Power:	100 MVA
VecGr.:	YN/yn0
Uprim:	220.000 V
Iprim:	262.5 A
Usec:	110.000 V
Isec:	525.0 A
Uk:	10.2%

Enter the first word "Substation" and then a tab. Proceed with "Buers" and a carriage return. Proceed accordingy:

Sub.	⇥	Buers	↵
Trans.	⇥	TR24	↵
Manuf.	⇥	Siemens	↵
Type	⇥	*a.s.o.*	↵

The tab quasi denotes a column-break.

The difference between Form Editor and Text Editor is that text left of the tab (the "first column", so to speak) cannot be accessed anymore in Text Editor, i.e., it is protected. To add, edit or delete first column entries use the Form Editor.

How to change a comment

If you need to change an existing comment, press **Edit**. This starts the *String Editor*.

Start the appropriate input mode, "Form Editor" or "Text Editor", change the entries of your choice and press **OK**.

How to clear a comment

Press **Clear Comment**. The context-dependent menu keys change and provide two more keys: **Clear All** and **Clear Text**.

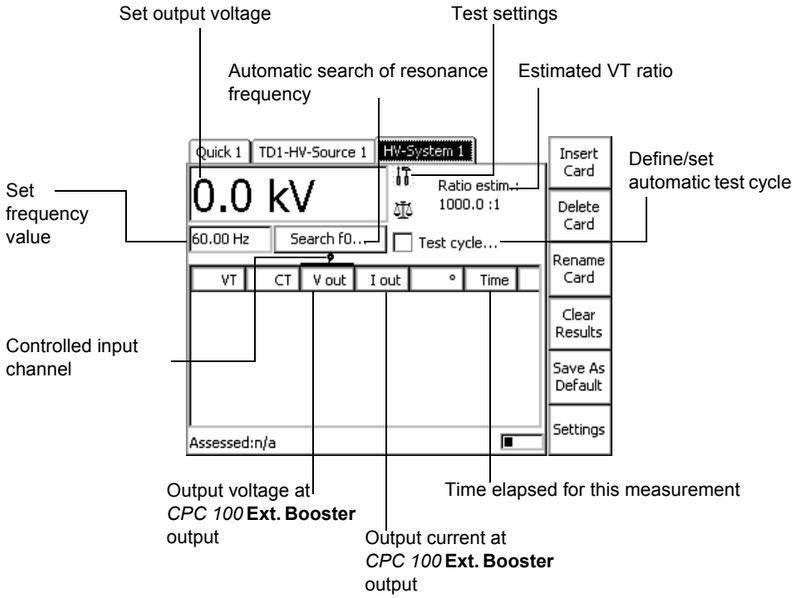
Clear All:	Deletes the entire comment at once, i.e. all text in all columns.
Clear Text:	Deletes all to the right of the tab, i.e. everything but the left-hand side column.

Others: HV Resonance Test System

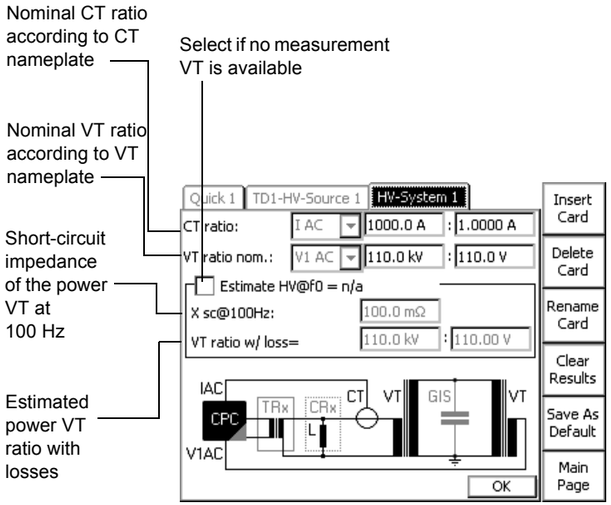
CPC 100 V 3.10

General

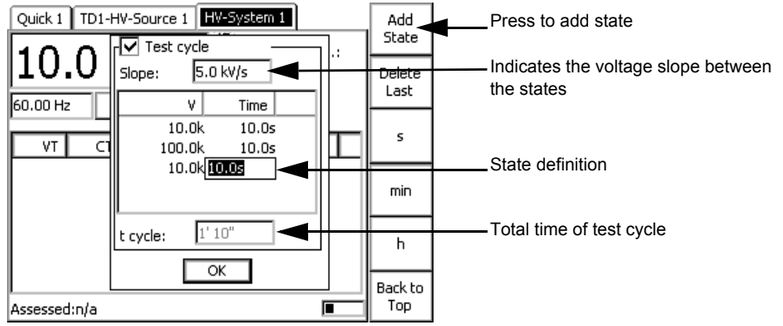
The **HV Resonance Test System** test card is used for generic high-voltage tests on GIS with a resonance circuit in combination with the *CP TR8* as well as *CP CR4* and *CP CR6*.



Test Settings



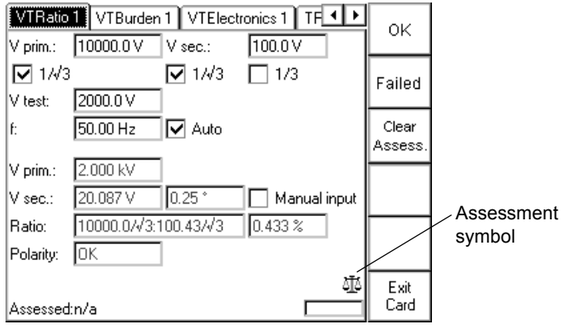
To set the test cycle:



Test Assessment

The test assessment is a manual procedure carried out by the user.

The example below shows an assessment made at a **VTRatio** test card. However, the assessment procedure is carried out in the same fashion on all test cards.



- After the test, set the focus on the assessment symbol by turning the handwheel.

Test not assessed.

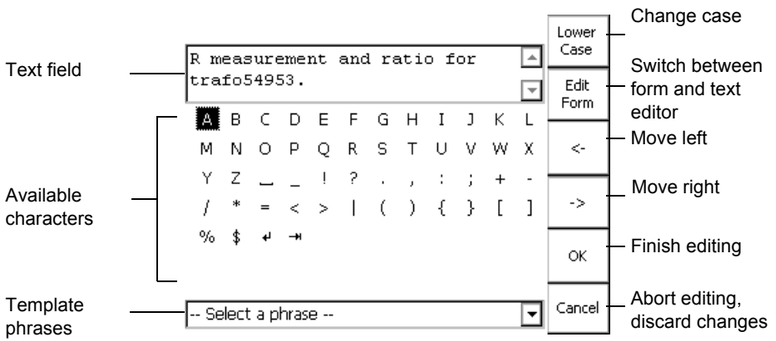
- Use the context-dependent menu keys to assess the test.

Test OK

Test failed

The *String Editor* is used to name or rename test cards, tests and templates as well as to fill out the **Comment** card.

Any time such an operation becomes necessary, the *String Editor* starts automatically.



The number of available characters to choose from depends on the *String Editor*'s use. If, for example, a user-defined comment is to be entered in the **Comment** card, the number of available characters is bigger than if a test is to be renamed. This difference are special characters, such as !, ?, _, [ ], etc.

Important special characters

↵ carriage return (line feed)

⇥ tab (special function in Form Editor mode; refer to page Others-7).

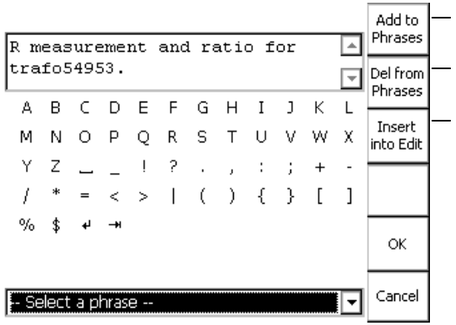
To change the default name, and to enter a name of your choice:

- delete the default name by repeatedly pressing the backspace key
- enter the new test or folder name by consecutively selecting the characters of your choice from the "on-screen keyboard" with the **Up / Down** keys or by navigating to it with the handwheel
- acknowledge every selected character by pressing the handwheel or **Enter**

The String Editor

The Template Phrases

The *String Editor* provides a feature, that allows you to save phrases, i.e., names of test cards, tests, templates, folders and files. Once these phrases are saved, they can then be selected as template phrases from the **Select a phrase** combo box.



— Define new template phrase

— Delete selected template phrase

— Add selected template phrase to the actual cursor position in text field

How to Save a Phrase

- enter a name of your choice in the way described above
- put the focus on the **Select a phrase** combo box
- press **Add to Phrases** to add this name to the list of template phrases.

CPC 100 Technical Data

CPC 100 V 3.10

Generator / Output Section - Current Outputs

Note: For detailed information refer to the section “Technical Data” in the CPC 100 Reference Manual available in pdf format on the *CPC 100 Toolsets* or the *CPC 100 Start Page*.

The output is either voltage or current, and is automatically selected by the software or manually by the user. Current and voltage outputs are overload and short-circuit proof and protected against over-temperature.

Range	Amplitude	t_{max}[1]	V_{max}[2]	$Power_{max}$[2]	f
800A AC[3]	0 … 800 A	25 s	6.0 V	4800 VA	15 … 400 Hz
	0 … 400 A	8 min	6.4 V	2560 VA	15 … 400 Hz
	0 … 200 A	> 2 h	6.5 V	1300 VA	15 … 400 Hz
6A AC[10]	0 … 6 A	> 2 h	55 V	330 VA	15 … 400 Hz
3A AC[10]	0 … 3 A	> 2 h	110 V	330 VA	15 … 400 Hz
400A DC	0 … 400 A	2 min	6.5 V	2600 VA	DC
	0 … 300 A	3 min	6.5 V	1950 VA	DC
	0 … 200 A	> 2 h	6.5 V	1300 VA	DC
6A DC[4, 10]	0 … 6 A	> 2 h	60 V	360 VA	DC
2000A AC[3] with an optional current booster. For more details, refer to page CP CB2-1.					

Generator / Output Section - Voltage Outputs

Range	Amplitude[5]	t_{max}	I_{max}	$Power_{max}$[5]	f
2kV AC[3]	0 … 2 kV	1 min	1.25 A	2500 VA	15 … 400 Hz
	0 … 2 kV	> 2 h	0.5 A	1000 VA	15 … 400 Hz
1kV AC[3]	0 … 1 kV	1 min	2.5 A	2500 VA	15 … 400 Hz
	0 … 1 kV	> 2 h	1.0 A	1000 VA	15 … 400 Hz
500V AC[3]	0 … 500 V	1 min	5.0 A	2500 VA	15 … 400 Hz
	0 … 500 V	> 2 h	2.0 A	1000 VA	15 … 400 Hz
130V AC[10]	0 … 130 V	> 2 h	3.0 A	390 VA	15 … 400 Hz

Output transient characteristics

	Changes from “off” or a low magnitude to a higher magnitude	Changes from a high magnitude to a lower magnitude or “off”
AC current	within one period	300 ms maximum; accordingly less for smaller magnitudes
AC voltage	1200 ms maximum; accordingly less for smaller magnitudes	300 ms maximum; accordingly less for smaller magnitudes

Internal Measurement of Outputs

Output	Range	Guaranteed accuracy			Typical accuracy[6]		
		Amplitude		Phase	Amplitude		Phase
		Reading error	Full scale error	Full scale error	Reading error	Full scale error	Full scale error
800A AC	-	0.20%	0.20%	0.20°	0.10%	0.10%	0.10°
400A DC	-	0.40%	0.10%	-	0.20%	0.05%	-
2kV AC	2000 V	0.10%	0.10%	0.20°	0.05%	0.05%	0.10°
	1000 V	0.10%	0.10%	0.30°	0.05%	0.05%	0.15°
	500 V	0.10%	0.10%	0.40°	0.05%	0.05%	0.20°
	5 A	0.40%	0.10%	0.20°	0.20%	0.05%	0.10°
	500 mA	0.10%	0.10%	0.20°	0.05%	0.05%	0.10°

Note: For the individual notes, see “Notes regarding Inputs and Outputs” below.

Measuring Inputs

Input	Imped.	Range	Guaranteed accuracy			Typical accuracy[6]		
			Amplitude		Phase	Amplitude		Phase
			Reading error	Full scale error	Full scale error	Reading error	Full scale error	Full scale error
IAC/DC[4, 7]	**< 0.1 Ω**	10A AC	0.10%	0.10%	0.20°	0.05%	0.05%	0.10°
		1A AC	0.10%	0.10%	0.30°	0.05%	0.05%	0.15°
		10A DC	0.05%	0.15%	-	0.03%	0.08%	-
		1A DC	0.05%	0.15%	-	0.03%	0.08%	-
V1 AC[8]	**500 kΩ**	300 V	0.10%	0.10%	0.20°	0.05%	0.05%	0.10°
		30 V	0.10%	0.10%	0.20°	0.05%	0.05%	0.10°
		3 V	0.20%	0.10%	0.20°	0.10%	0.05%	0.10°
		300 mV	0.30%	0.10%	0.20°	0.15%	0.05%	0.10°
V2 AC[8, 11]	**10 MΩ**	3 V	0.05%	0.15%	0.20°	0.03%	0.08%	0.10°
		300 mV	0.15%	0.15%	0.20°	0.08%	0.08%	0.10°
		30 mV	0.20%	0.50%	0.30°	0.10%	0.25%	0.15°
V DC[4, 7]		10 V	0.05%	0.15%	-	0.03%	0.08%	-
		1 V	0.05%	0.15%	-	0.03%	0.08%	-
		100 mV	0.10%	0.20%	-	0.05%	0.10%	-
		10 mV	0.10%	0.30%	-	0.05%	0.15%	-

Output to Input Synchronization

	Test cards Quick, Sequencer, Ramping	Test card Amplifier
Frequency range	48 … 62 Hz	
Synchronization inputs	V1 AC (automatic range switching)	V1 AC, V2 AC, I AC (fixed to maximum range)
Input magnitude	10% of input range full scale	
Output magnitude	5% of output range full scale	
Settling time	100 ms after 5% of output magnitude is reached	1000 ms after 5% of output magnitude is reached
Signal changes	All quantities must be ramped within 20 signal periods	No changes of frequency and phase. Magnitude changes without limitation. Output follows within 250 ms.
Phase tolerance	0.5° within the limits as specified above	

Notes Related to Inputs and Outputs

All input/output values are guaranteed over one year within an ambient temperature of 23 °C ± 5 ° (73 °F ± 10 °F), a warm-up time longer than 25 min and in a frequency range of 45 … 60 Hz or DC. Accuracy values indicate that the error is smaller than ± (value read x reading error + full scale of the range x full scale error).

1. With a mains voltage of 230 V using a 2 x 6 m high-current cable at an ambient temperature of 23 °C ± 5 ° (73 °F ± 10 °F)
2. Signals below 50 Hz or above 60 Hz with reduced values possible.
3. Output can be synchronized with V1 AC in **Quick**, **Sequencer**, **Ramping** and **Amplifier**.
4. The input / output is protected with lightning arrestors between the connector and against protective earth. In case of energy above a few hundred Joule the lightning arrestors apply a permanent short-circuit to the input / output.
5. Signals below 50 Hz or above 200 Hz with reduced values possible.
6. 98% of all units have an accuracy better than specified as *typical.*
7. Input is galvanically separated from all other inputs
8. V1 and V2 are galvanically coupled but separated from all other inputs.
9. There are power restrictions for mains voltages below 190V AC.
10. Fuse-protected
11. When using the **CTRogowski** test card, the 3V **V2 AC** input uses an additional software based integration method. In the range of 50 Hz < f < 60 Hz, this results in a phase shift of 90° as well as an additional phase error of +/- 0.1° and an additional amplitude error of +/- 0.01%. For frequencies in the range of 15 Hz < f < 400 Hz, the phase error is not specified, and the amplitude error can be up to +/- 0.50% higher.

Measuring Inputs

Additional Features of the Measuring Inputs

- Automatic range switching (except test card **Amplifier**)
- Galvanically separated potential groups: **I AC / DC**; **V1** & **V2**; **V DC**
- AC frequency range 15 … 400 Hz (except test card **Amplifier**)
- Protection of **I AC / DC** input: 10A FF fuse[4]

Binary input for dry contacts or voltages up to 300V DC[7]

Trigger criteria	Toggling with potential-free contacts or voltages of up to 300 V
Input impedance	> 100 kΩ
Response time	1 ms

Resistance Measurement

The accuracy of the resistance measurements can be calculated from the respective input and output specifications.

4-wire measurement with 400A DC output and 10V VDC input				
Current	Resistance	Voltage	Typ. error	Guaranteed
400 A	10 µΩ	4 mV	0.70%	1.35%
400 A	100 µΩ	40 mV	0.55%	1.10%
400 A	1 mΩ	400 mV	0.50%	0.95%
400 A	10 mΩ	4 V	0.50%	0.95%

4-wire measurement with 6A DC output and 10V VDC input				
Current	Resistance	Voltage	Typ. error	Guaranteed
6 A	100 mΩ	0.6 V	0.35%	0.60%
6 A	1 Ω	6 V	0.35%	0.60%
1 A	10 Ω	10 V	0.25%	0.40%

2-wire measurement with 10V VDC input				
Current	Resistance	Voltage	Typ. error	Guaranteed
< 5 mA	100 Ω		0.60%	1.20%
< 5 mA	1 kΩ		0.51%	1.02%
< 5 mA	10 kΩ		0.50%	1.00%

General

Display	¼ VGA greyscale LCD display
Power supply	
Single-phase, nominal[9]	100V AC … 240V AC, 16A
Single-phase, permissible	85V AC … 264V AC (L-N or L-L)
Frequency, nominal	50/60 Hz
Power consumption	< 7000 VA for a time < 10 s
Connection	IEC320/C20
Environmental conditions	
Operating temperature	-10 ° … +55 °C (+14 … +131 F)
Storage temperature	-20 ° … +70 °C (-4 … +158 F)
Humidity range	5 … 95% relative humidity, no condensation
Shock	IEC68-2-27 (operating), 15 g/11 ms, half-sinusoid
Vibration	IEC68-2-6 (operating), 10 … 150 Hz, acceleration 2 g continuous (20 m/s²); 10 cycles per axis
EMC	EN 50081-2, EN 55011, EN 61000-3-2, FCC Subpart B of Part 15 Class A, EN 50082-2, IEC 61000-4-2/3/4/8, CE conform (89/336/EEC)
Safety	EN 61010-1, EN 60950, IEC 61010-1, produced and tested in an EN ISO 9001 certified company.
Prepared for	IEEE 510, EN 50191, VDE 104

General

Weight and Dimensions

Weight	29 kg (64 lbs), robust case with cover
Dimensions	W x H x D: 468 x 394 x 233 mm (18.4 x 15.5 x 9.2"), cover, without handles.

CP TD1

Safety Instructions

Note: On principle, the safety instructions relevant to the *CPC 100* and its accessories (refer to page Preface-1) also apply to the *CP TD1*. This section lists safety instructions that exclusively apply to the *CP TD1*.

Handling cables

- Always turn off the *CP TD1* completely before you connect or disconnect any cable (disconnect the *CPC 100* from mains or press its Emergency Stop button).
- The high-voltage cable must always be well attached and tightly connected to both the *CP TD1* and the test object. A loose or even falling off connector at the test object carrying high voltage is life-hazardous. Make sure the connectors are clean and dry before connecting.
  At the *CP TD1*, press the high-voltage cable's plug to the connector tightly and turn the screw cap until you feel a mechanical stop. If you notice a rough-running of the screw-cap, clean the screw thread and use a lubricant (vaseline recommended).

  Note: Tighten the plugs manually. Do not use any tools for that because that can damage the plugs or connectors.
  Insert the yellow banana plug (the high-voltage cable's grounding) into the respective plug socket.
- Do not connect any cable to the test object without a visible grounding of the test object.
- The high-voltage cable is double-shielded and therefore safe. However, the last 50 cm (20 inch) of this cable have no shield. Therefore, during a test consider this cable a life wire and due to the high voltage life-hazardous!

Warning: When the *CPC 100* is switched on, consider this part of the cable a hazard of electric shock!

- Never remove *any* cables from the *CP TD1* or the test object during a test.
- Keep clear from zones in which high voltages may occur. Set up a barrier or establish similar adequate means.
- Both low-voltage measuring cables must always be well attached and tightly connected to the *CP TD1*'s measuring inputs IN A and IN B.
  Make sure to insert the red and blue marked cables into the corresponding measuring inputs: IN A = red, IN B = blue.
  Tighten the plugs by turning them until you feel a stop.

  Note: Tighten the plugs manually. Do not use any tools for that because that can damage the plugs or connectors.
- Do not use any other cables than the ones supplied by OMICRON electronics.

Product Description - Designated Use

The *CP TD1* is an optionally available high-precision test system for on-site insulation tests of high-voltage systems like power and measuring transformers, circuit breakers, capacitors and isolators. With the add-on device *CP TD1*, the *CPC 100* increases its range of possible applications into high-voltage measurements.

The internal switched mode power amplifier enables measuring at different frequencies without interferences with the mains frequency. Automatic test procedures reduce the testing time to a minimum. Test reports are generated automatically.

The *CP TD1* comes with its own test card named **TanDelta** (Tangent Delta), which provides highly accurate measurements of the capacitance Cx and the dissipation factor tanδ (DF) or power factor cosφ (PF), respectively.

Both the dissipation factor and the power factor grant information about possible losses in the insulation material, which are increasing with age and water content. A change of Cx is a warning indicator for partial breakdowns between the layers of a bushing or a capacitor.

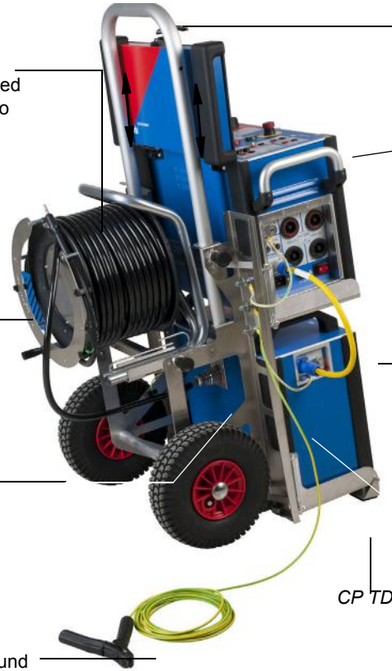
Additionally, the *CP TD1* measures the following quantities:

- Actual, apparent and reactive power
- Quality factor QF
- Inductance
- Impedance, phase angle
- Test voltage & current

The *CP TD1* works as an add-on device to the *CPC 100*. Do not connect the *CP TD1* to any other device. Do not use the accessories for applications not indicated in this User Manual.

Note: Any other use of the *CP TD1* but the one mentioned above is considered improper use, and will not only invalidate all customer warranty claims but also exempt the manufacturer from its liability to recourse.

Functional Components



Cable drum with double-shielded output cable to feed the high voltage to the test object

Equipment trolley

CPC 100

Cable drum for measuring cables

Booster cable *CPC 100* ⇔ *CP TD1* (short type). Via this cable the *CPC 100* controls the *CP TD1* output voltage.

High-voltage output with attached screw plug and yellow grounding plug.

CPC 100, CP TD1 and the equipment trolley connected to the trolley's grounding bar and led to earth.

CP TD1

Equipotential ground

Grounding cable min. 6 mm².

To secure the *CPC 100* while pulling the trolley, a safety belt is available (not shown).

Data cable *CPC 100* ⇔ *CP TD1* (short type). Via this data cable the *CPC 100* software (test card **TanDelta**) controls the *CP TD1*.

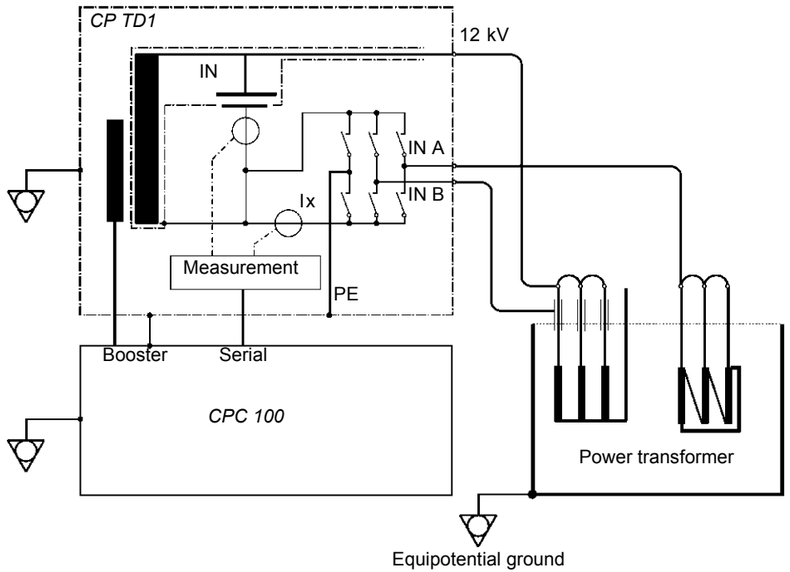
The *CP TD1*'s measuring inputs IN A and IN B, connected to the cable drum for the measuring cables

Swivelling mounting brackets for the *CPC 100* (top) and *CP TD1* (bottom)

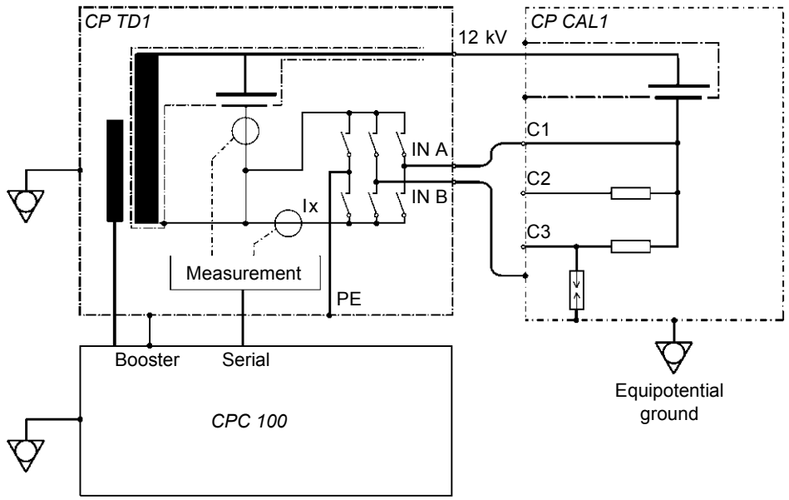
Setup of Devices with and without Trolley

- The equipment trolley holds the *CPC 100*, *CP TD1* and all required cables. The trolley is equipped with a grounding bar with three knurled screws to ensure a solid grounding to equipotential ground of all devices.
- If the *CPC 100* and *CP TD1* are to be operated without trolley, place them on their transport cases and connect them with the long type data cable *CPC 100* ⇔ *CP TD1* (3 m) and the long-type booster cable *CPC 100* ⇔ *CP TD1* (3 m). Each device has to be grounded separately with a 6 m grounding cable of at least 6 mm².

CP TD1 Connected to a Power Transformer



CP TD1 Connected to *CP CAL1*



When using the *CP CAL1* for calibration, we recommend to take C1 as reference and to select the calibration frequency in a range between 50 … 200 Hz.

Putting the *CP TD1* into Operation

As the first step, before you set a *CPC 100* / *CP TD1* measurement setup into operation, link the *CPC 100*, *CP TD1* and, if applicable, the equipment trolley with a min. 6 mm² grounding cable as displayed on page CP TD1-2.

Never use the *CPC 100* / *CP TD1* measurement setup without a solid connection to ground.

1. Switch off the *CPC 100* at the main power switch.
2. **With trolley**:
   Properly connect the *CPC 100* and *CP TD1* grounding terminals to the trolley's ground bar. Connect the ground bar to earth. All cables minimum 6 mm².
   Without trolley:
   Properly connect the *CPC 100* and *CP TD1* grounding terminals to earth. Both cables minimum 6 mm².
3. Connect the *CP TD1*'s "BOOSTER IN" to the *CPC 100*'s "EXT. BOOSTER" with the OMICRON electronics supplied booster cable.
4. Connect the *CP TD1*'s "SERIAL" to the *CPC 100*'s "SERIAL" with the OMICRON electronics supplied data cable. This cable also provides the power supply for the *CP TD1*.
5. Pull out the measuring cables from the cable drum and connect the test object to the *CP TD1*'s measuring inputs IN A and IN B.
6. Pull out the high-voltage cables from the cable drum and connect the test object to the *CP TD1*'s high-voltage output.
7. Switch on the *CPC 100*.
8. Selecting the **TanDelta** test card from any of the *CPC 100*'s **CT**, **VT**, **Transformer** or **Others** test card groups automatically turns on the *CP TD1*. If no *CP TD1* is connected to the *CPC 100*, an error message appears.
9. Set up your measurement in the **TanDelta** test card (see page CP TD1-5).
10. Press the *CPC 100*'s I/O (test start / stop) push-button.

Calibrate the *CP TD1* Using a Reference Capacitor

By connecting a reference capacitor (e.g., optional device *CP CAL1*) with known values of capacity Cref and dissipation factor DFref, in mode UST-A the values Cx and DFx can be measured and then compared to the known reference values.

If you experience substantial deviations, re-calibrate the *CP TD1*:

- Cx = Cref / Cmeas and
- DF / PF + = DFref - DFmeas

as described on page CP TD1-6.

A re-calibration of the *CP TD1* is also shown in the test report (`.xml` file).

Note: If you change the factory-made calibration, the responsibility for the accuracy of the *CP TD1* will be in your hands.

Calibration tips:

- For calibration, set the averaging factor to maximum and the filter bandwidth to ± 5 Hz (refer to page CP TD1-5).
- To reset to the factory settings, select "DF/PF+" to 0.0 ppm and "Cx" to 1.000 (refer to page CP TD1-6).

Option *TH 3631*

Use the optional device *TH 3631* to measure ambient temperature, the test object temperature and humidity. Once these values were measured, enter them into the respective entry fields of the **TanDelta** test card's **Settings** page at "Compensations" (see page CP TD1-6).

Application and Test Templates

For detailed information on the *CP TD1* applications, refer to the CP TD1 Reference Manual delivered with the *CP TD1* or available in pdf format on the *CPC 100 Start Page*.

Test Templates

The test procedures for designated applications are controlled by templates available on the *CPC 100 Toolsets* shipped with your *CP TD1* or on the *CPC 100 Start Page*.

Test templates are available for the following areas:

- power transformers
- instrument transformers
- rotating machines
- cables and transmission lines
- grounding systems
- others

TanDelta-PF Test Card - Main Page

The **TanDelta-PF** test card can be accessed from **CT**, **VT**, **Transformer** and **Others** test card groups.

Select "Assessment" to automatically assess the test, clear for no assessment.
Enter the nominal values in the entry fields (here "Cref" and "DFref"; availability and naming depend on the measuring mode). These values serve as reference for the assessment. Their tolerance range can be set on the **Settings** page (see page CP TD1-6).
A measurement is rated as 'OK' if **both** values are within their tolerance range. The assessment is displayed in the test point tables's column "?"

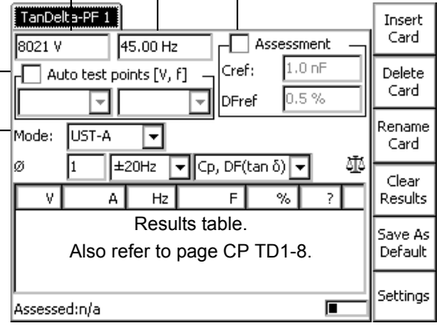
Note: While a test is running, new nominal values can already be entered.

Test voltage and frequency.

Select for automatic measurement, clear for manual measurement.*).

Selecting enables the list boxes.

Selecting a measuring mode and pressing the handwheel displays an image that shows the according arrangement of the internal measurement switch-matrix.**)



*) **"Auto test points" cleared = manual measurement:** Applies the set test voltage and frequency to the *CP TD1*'s output. When the measurement is finished, its results are displayed in the results table.

"Auto test points" selected = automatic measurement: Enables the output of a series of test points, e.g., combining a series of voltage values with one fixed frequency value creates a voltage ramp. Combining a series of frequency values with one fixed voltage value creates a frequency ramp. Furthermore, a combination of both is possible.

- Set a test voltage and frequency of your choice, and press **Add to Auto**. The values are entered into the list boxes.
- Set a second test voltage and/or frequency, and again press **Add to Auto**. The value(s) is/ are appended to the list.
- Repeat this procedure as often as you need.

Note: You cannot enter the same value twice. Double entries are rejected. If you need identical test points for an increasing and a decreasing voltage ramp, set values very close to each other, e.g., 2000 V and 2001 V.

The *CP TD1* then puts out the specified list of values as follows:

1. All voltages are issued in the exact order they were entered using the *first* frequency value of the list.
2. All voltages are issued once more in the exact order they were entered using the *second* frequency value of the list (if any).
3. ... and so forth.

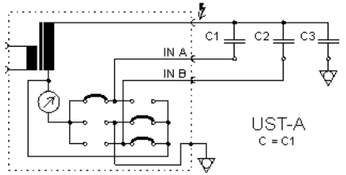
Each combination is one individual measurement, and its result is displayed in the results table with an individual line.

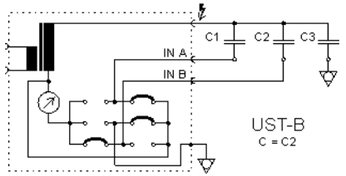
To delete an entry from a list box, place the cursor on the value and press **Delete Value**. Do delete all values from both list boxes, place the cursor on "Auto test points (V, f)" and press **Delete List**.

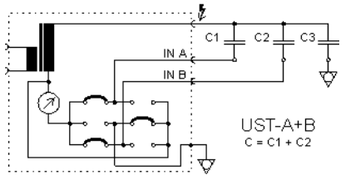
During the measurement, the list boxes display the current output values.

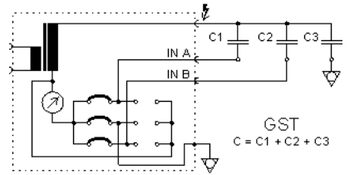
**)Measuring modes and their according arrangements of the internal switch-matrix in the *CP TD1*.

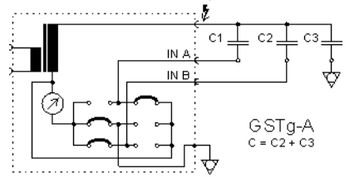
The switch-matrix determines what capacities are actually measured.

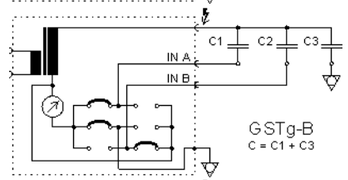


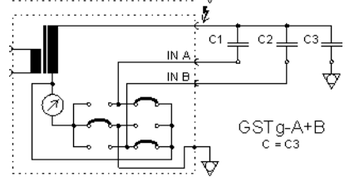








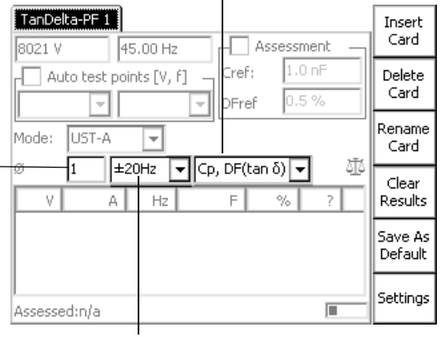




TanDelta-PF Test Card - Main Page

Compound measurement setting

Cp, DF (tan δ) = parallel capacitance & dissipation factor
Cp, PF (cos φ) = parallel capacitance & power factor
Cp, Ptest = parallel capacitance & power
Cp, P@10kV = parallel capacitance & power; linearly interpolated to 10 kV test voltage
Qtest, Stest = reactive & apparent power
Z = impedance with phase angle
Cp, Rp = parallel capacitance & parallel resistance
Ls, Rs = serial inductance & serial resistance
Cp, QF = parallel capacitance & quality factor
Ls, QF = series inductance & quality factor



The averaging factor determines the number of measurements. A factor of 3 means: the *CP TD1* carries out 3 measurements whose results are then averaged. The higher the factor, the more accurate the measurement but the longer the measuring time.

Filter bandwidth of measurement.

Note: If the test frequency equals the default frequency (as set at **Options** | **Device Setup**), the filter bandwidth is always ± 5 Hz, regardless of the set value. This even applies if the option "use default frequency of xx.xx Hz" is not specifically selected.
± 5 Hz means that interferences at frequencies with an offset of ≥ ± 5 Hz from the measuring frequency will not affect the results.
The smaller the filter bandwidth, the longer the measuring time.

TanDelta-PF Test Card - Settings Page

Pressing the **Settings** button on the **TanDelta** main page opens the **Settings** page allowing you to set additional measurement options.

The *CP TD1* leaves OMICRON electronics factory-calibrated. If a component needs to be exchanged by a spare part, the *CP TD1* must be re-calibrated.
To re-calibrate, set the focus onto the test card tab designation **TanDelta** and press **Edit Calib** to enable the entry fields:

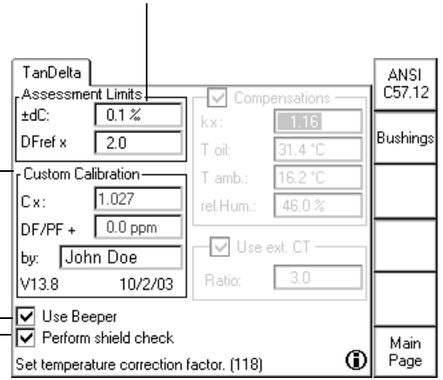
- Cx = correction factor for Cmeas (multiplier)
- DF/PF + = corrective value added to dissipation or power factor (can be + or -)

Note: You must enter your name and press **Update Calib** to complete the re-calibration.
See also figure *CP TD1* ⇔ *CP CAL1* on page CP TD1-3.

If selected, the beeper sounds during the entire test. If cleared, the beeper sounds at the beginning and the end of the test only.

At "Assessment Limits", set the tolerance of the main page's nominal values for the assessment. For the capacitance, the tolerance is entered in percent, for the dissipation factor it's a multiplier.

Note: Availability and naming of the entry fields depend on the measuring mode, e.g., DF and PF are the same entry field.



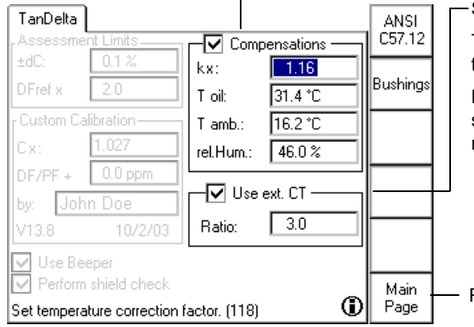
If selected, the *CPC 100* checks whether the shield of the high-voltage cable is connected. For some large inductive loads, the *CPC 100* can accidentally report shield check error even when the shield is connected. If this is the case, it makes sense to clear the check box.

Selecting "Compensations" converts the actually measured dissipation or power factor to normalized values corresponding to an ambient temperature of 20 °C. In doing so, the values entered at "Compensations" represent the existing ambient condition.

- Enter oil temperature, ambient temperature (at bushing) and relative humidity first.
- Then place the cursor on "k".

The medium the measurement takes place in, oil or air, determines the k-factor.

- **ANSI C57.12**
  The oil temperature is the determining medium for the k-factor.
- **Bushings**
  The air temperature at the respective bushing is the determining medium for the k-factor. **Bushings** provides three bushing types to select from: RBP (**R**esin **B**onded **P**aper), RIP (**R**esin **I**mpregnated **P**aper) and OIP (**O**il **I**mpregnated **P**aper). The k-factor changes accordingly.



Select if you use an external CT.

The entered ratio is used to calculate the measured current accordingly.

Note: "Use ext. CT" can only be selected if there are no measurement results yet.

Returns to **TanDelta**'s main page

CP TD1 High-Voltage Source

In addition to the Dissipation Factor (TanDelta)/Power Factor test, the *CP TD1* can also be used as a high-voltage source for measuring, for example, partial discharge or conducting high-voltage tests on rotating machines.

To compensate capacitive currents, a parallel resonance circuit can be set up.

The compensation using the *CP CR500* compensation reactor is realized in two different ways: First, by parallel circuiting the compensation reactors to measure as close as possible to the resonance frequency when measuring with nominal frequency is required. Second, by setting the frequency to measure at exactly the resonance frequency. The longest output duration is achieved with testing at resonance frequency, in most cases accomplished by a combination of both procedures.

The **CP TD1 High-Voltage Source** test card can be used both for manual or fully automatic testing by toggling defined ramps and sequences. The test card is also helpful in setting up the optimum test configuration to achieve the best possible test duration.

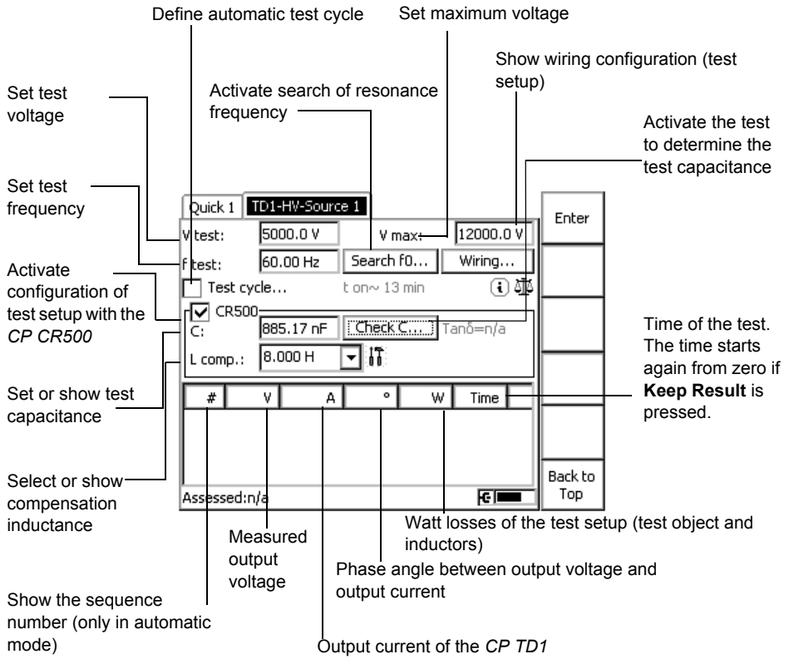
Typical Test Procedure

- **Without compensation**

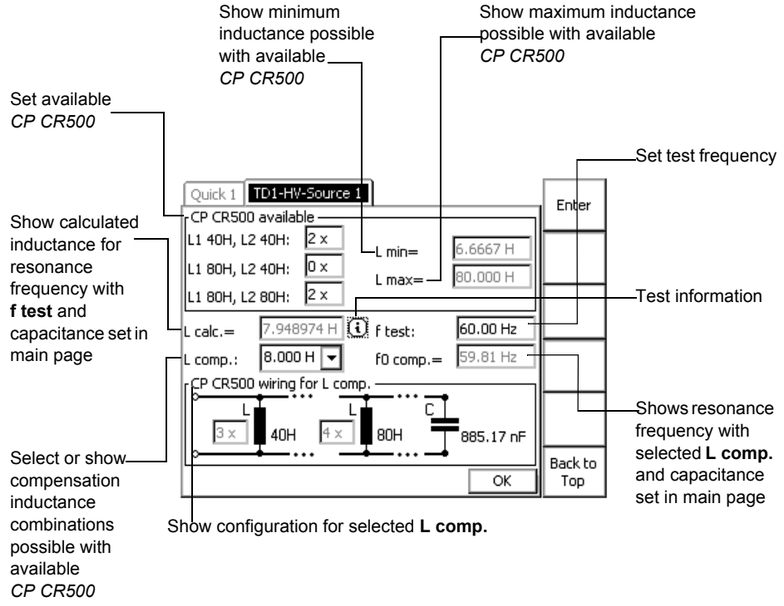
If the capacitance of the test object is smaller than 80 nF (up to 12 kV and **t on** > 2 min.), no compensation is required.

- **With compensation**

1. Determine the capacitance of the test object
2. Calculate the inductors needed for the compensation
   - manual calculation
   - by using the **CP TD1 High-Voltage Source** test card
3. Set the test voltage
4. Set **f test** (manually or with **Search f0…**)
5. Start the test (define test cycle before, if required)



Test Settings



Technical Data of the *CP TD1* in Combination with the *CPC 100*

High-Voltage Output

Conditions: Signals below 45 Hz with reduced values possible. Capacitive linear loads.

Terminal	U / f	THD	I	S	t_{max}
High-voltage output	10 … 12 kV AC	< 2%	300 mA	3600 VA	> 2 min
	15 … 400 Hz		100 mA	1200 VA	> 60 min

Measurements

Test frequencies

Range	Resolution	Typical accuracy
15 … 400 Hz	0.01 Hz	error < 0.005% of reading

TanDelta test card: Column “Hz” of the results table

Special displays in the frequency column “Hz” and their meanings:

*50 Hz (*60 Hz)	Measurement mode suppressing the mains frequency interferences; doubles the measurement time.
!30 Hz	The selected test voltage is not available in Automatic measurement (applies to frequencies below 45 Hz only).
?xx Hz	Results with reduced accuracy, e.g., in case of a low testing voltage, influences of partial discharge etc.

Filter for selective measurements

Conditions: f0 = 15 … 400 Hz

Filter bandwidth	Meas. time	Stop band specification (attenuation)
f0 ± 5 Hz	2.2 s	> 110 dB at fx = f0 ± (5 Hz or more)
f0 ± 10 Hz	1.2 s	> 110 dB at fx = f0 ± (10 Hz or more)
f0 ± 20 Hz	0.9 s	> 110 dB at fx = f0 ± (20 Hz or more)

Test current (RMS, selective)

Terminal	Range	Resolution	Typical accuracy	Conditions
IN A or IN B[a]	0 …5A AC	5 digits	error < 0.3% of reading + 100 nA	Ix < 8 mA
			error < 0.5% of reading	Ix > 8 mA

[a]) IN A (red) or IN B (blue), depending on the mode.

Test voltage (RMS, selective)

Range	Resolution	Typical accuracy
0 … 12000V AC	1 V	error < 0.3% of reading + 1 V

Capacitance Cp (equivalent parallel circuit)

Range	Resolution	Typical accuracy	Conditions
1 pF … 3 µF	6 digits	error < 0.05% of reading + 0.1 pF	Ix < 8 mA, Vtest = 300 V … 10 kV
		error < 0.2% of reading	Ix > 8 mA, Vtest = 300 V … 10 kV

Dissipation factor DF (tanδ)

Range	Resolution	Typical accuracy	Conditions
0 … 10% (capacitive)	5 digits	error < 0.1% of reading + 0.005%[a]	f = 45 … 70 Hz, I < 8 mA, Vtest = 300 V … 10 kV
0 … 100 (0 … 10000%)	5 digits	error < 0.5% of reading + 0.02%	Vtest = 300 V … 10 kV

Power factor PF (cosφ)

Range	Resolution	Typical accuracy	Conditions
0 … 10% (capacitive)	5 digits	error < 0.1% of reading + 0.005%[a]	f = 45 … 70 Hz, I < 8 mA, Vtest = 300 V … 10 kV
0 … 100%	5 digits	error < 0.5% of reading + 0.02%	Vtest = 300 V … 10 kV

[a]) Reduced accuracy of DF and PF at mains frequency or its harmonics. Mains frequency suppression available by precisely selecting a mains frequency of *50 Hz or *60 Hz in the “Hz” column.

Technical Data of the *CP TD1* in Combination with the *CPC 100*

Phase angle φ

Range	Resolution	Typical accuracy	Conditions
-90 ° … +90 °	4 digits	error < 0.01 °	Vtest = 300 V … 10 kV

Impedance Z

Range	Resolution	Typical accuracy	Conditions
1 kΩ … 1200MΩ	6 digits	error < 0.5% of reading	Vtest = 300 V … 10 kV

Inductance Lx (equivalent serial circuit)

Range	Resolution	Typical accuracy
1 H … 1000 kH	6 digits	error < 0.3% of reading

Quality factor QF

Range	Resolution	Typical accuracy
0 … 1000	5 digits	error < 0.5% of reading + 0.2%
> 1000	5 digits	error < 5% of reading

Power P, Q, S (selective)

Range	Resolution	Typical accuracy
0 … 3.6 kW	6 digits	error < 0.5% of reading + 1 mW
0 … 3.6 kvar	6 digits	error < 0.5% of reading + 1 mvar
0 … 3.6 kVA	5 digits	error < 0.5% of reading + 1 mVA

Mechanical Data

Environmental conditions

Operating temperature	-10 ° … +55 °C (+14 … +131 F)
Transport and storage temperature	-20 ° … +70 °C (-4 … +158 F)
Humidity range	5 … 95% relative humidity, no condensation
Shock	IEC68-2-27 (operating), 15 g/11 ms, half-sinusoid
Vibration	IEC68-2-6 (operating), 10 … 150 Hz, acceleration 2 g continuous (20 m/s²); 5 cycles per axis
EMC	EN 50081-2, EN 55011, EN 61000-3-2, FCC Subpart B of Part 15 Class A, EN 50082-2, IEC 61000-4-2/3/4/8, CE conform (89/336/EEC)
Safety	EN 61010-1, EN 60950, IEC 61010-1, produced and tested in an EN ISO 9001 certified company.
Prepared for	IEEE 510, EN 50191, VDE 104

Weight and dimensions

		Weight	Dimensions (W x H x D)
CP TD1	test set	25 kg (55.2 lbs)	450 x 330 x 220 mm (17.7 x 13 x 8.7”) without handles
	test set & case[a]	38.1 kg (84 lbs)	700 x 500 x 420 mm (27.5 x 19.7 x 16.5”)
CP CAL1	test set	8.8 kg (19.4 lbs)	450 x 330 x 220 mm (17.7 x 13 x 8.7”) without handles
	test set & case[a]	21 kg (46.3 lbs)	700 x 500 x 420 mm (27.5 x 19.7 x 16.5”)
Cables and accessories	equipment	16.6 kg (36.6 lbs)	
	equipment and case[a]	26.6 kg (58.7 lbs)	680 x 450 x 420 mm (26.8 x 17.7 x 16.5”)
Equipment trolley	equipment	14.5 kg (32 lbs)	
	equipment & carton	18.9 kg (41.7 lbs)	590 x 750 x 370 mm (23.2 x 29.2 x 14.6”)
CP TD1, *CPC 100*, equipment & trolley (without *CP CAL1*)	equipment	85 kg (187.5 lbs)	750 x 1050 x 600 mm (29.5 x 41.3 x 23.6”)
	equipment & packing	125 kg (275.8 lbs)	

[a]) Case = robust case, IP22

CP TD1

CP CU1

Safety Instructions

Note: On principle, the safety instructions relevant to the *CPC 100* and its accessories (refer to page Preface-1) also apply to the *CP CU1*. This section lists safety instructions that exclusively apply to the *CP CU1*.

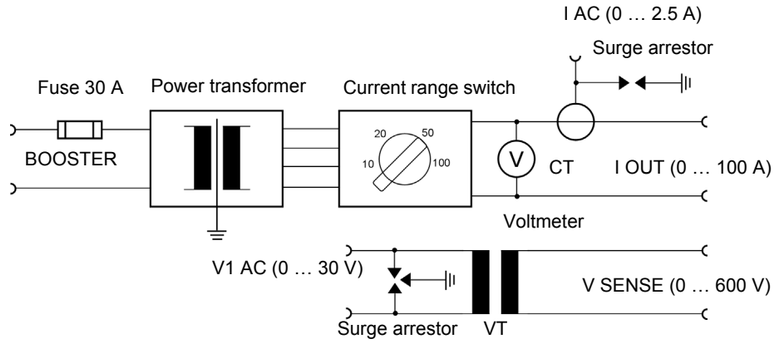
General

- Before operating the *CP CU1*, read the CP CU1 Reference Manual carefully and observe the safety rules and instructions therein.
- Before handling the *CP CU1* or *CPC 100* in any way, connect them with a solid connection of at least 6 mm² cross-section to ground. Ground the *CP CU1* as close as possible to the *CPC 100*.
- Use the *CP GB1* grounding box to connect the *CP CU1* to overhead lines and power cables. For detailed information, see the application-specific "Safety Instructions for Connecting *CP CU1* to Power Lines" in the CP CU1 Reference Manual.
- When using the *CP GB1*, ground it near the place where the connection to the test object is made. Make sure that the grounding stud is in good condition, clean and free of oxidation.
- Make sure that all studs and cables of the *CP GB1* are screwed tight.
- Make sure that the test object's terminals to be connected to the *CP CU1* do not carry any voltage potential. During a test, the only power source for a test object may be the *CP CU1* (powered by the *CPC 100*). The only exception are measurements on overhead lines as described in "Applications" in the CP CU1 Reference Manual.
- Use the *CP CU1*, *CP GB1* and their accessories only in a technically sound condition and when its use is in accordance with the regulations. In particular, avoid disruptions that could in turn affect safety.

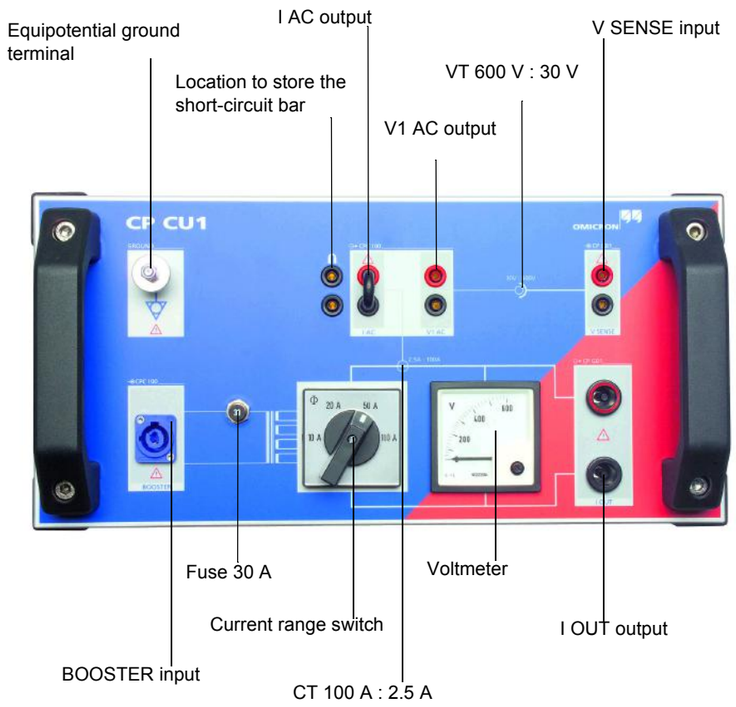
Operating the Measurement Setup

- When using the *CP GB1*, ground it near the place where the connection to the test object is made. Make sure that the grounding stud is in good condition, clean and free of oxidation.
- Life threatening voltages up to 600 V can appear on all *CP GB1* contacts and on all clamps and cables connected to the *CP CU1* during the test. Keep safe distance from them.
- Before handling the *CP CU1* or *CP GB1* in any way (even before setting the current range switch), make sure that the device under test (e.g. overhead lines or power cables) are well grounded (e.g. by closing the grounding switch) near the measurement setup.
- Ensure that the short-circuit bar is always plugged in the *CP CU1* **I AC** output whenever the output is not connected to the **I AC** input of the *CPC 100*.
- Connect the *CP CU1* **I AC** output exclusively to the **I AC** input of the *CPC 100*.
- Before connecting the *CP CU1* with the *CPC 100*, turn off the *CPC 100* either by the POWER ON/OFF switch or the Emergency Stop button.
- Set the current range switch on the *CP CU1* front panel only when the *CPC 100* is turned off and the test object is grounded.
- In addition to the above safety rules follow the application-specific "Safety Instructions for Connecting *CP CU1* to Power Lines" in the CP CU1 Reference Manual.
- The *CP CU1* may be used only as described in "Applications" in the CP CU1 Reference Manual. Any other use is not in accordance with the regulations. The manufacturer and/or distributor is not liable for damage resulting from improper usage. The user alone assumes all responsibility and risk.

Block Diagram



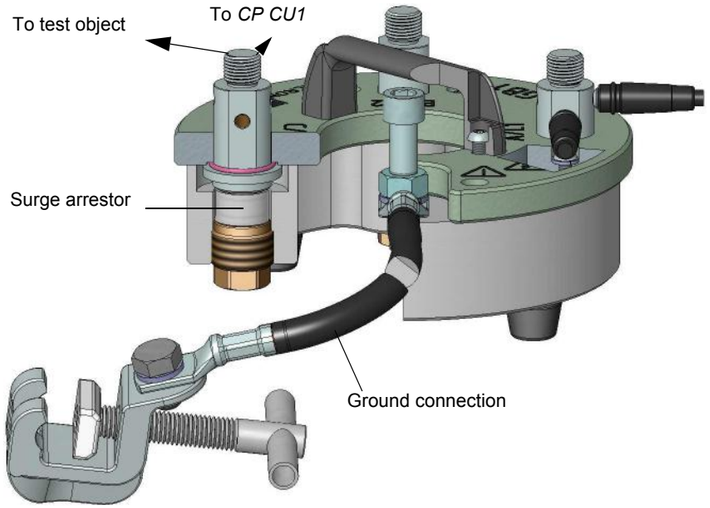
Functional Elements



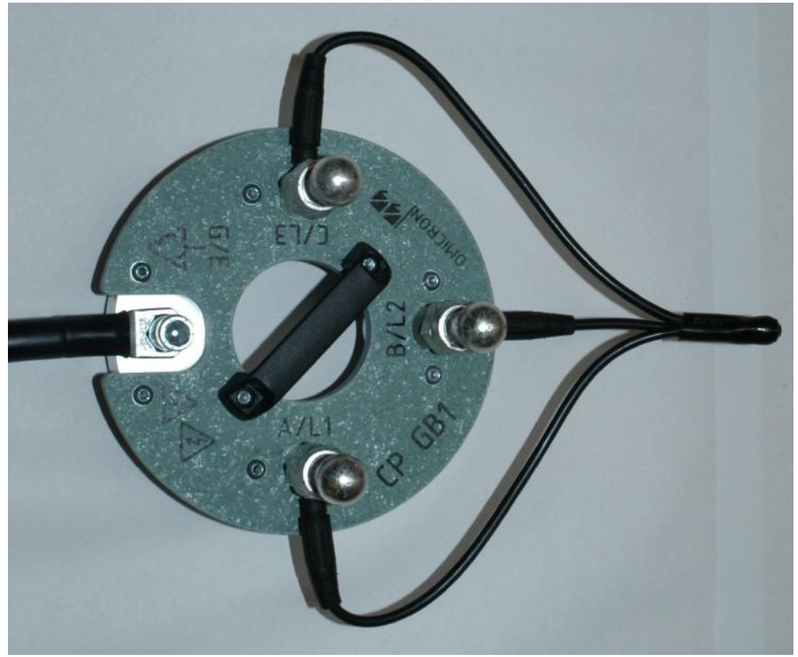
CP GB1 Grounding Box

The *CP GB1* grounding box is a surge arrestor unit for connecting the *CP CU1* to the test object. If high voltage appears for a short time on the test object's terminals, an arc discharges the voltage and extinguishes without destroying the grounding box. If the arc persists for a longer time period, the surge arrestor insulator melts and the terminals are short-circuited to ground, thereby protecting the operating staff, *CP CU1* and *CPC 100*.

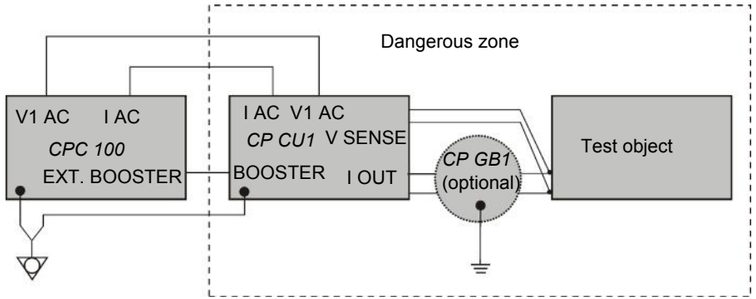
Warning: The *CP GB1* grounding box must be used for measurements on overhead lines or power cables.



To short the phases, connect the line studs of the *CP GB1* as shown below.



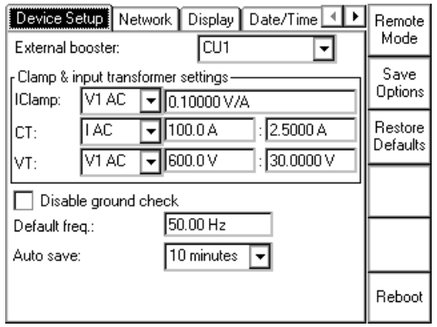
Measurement Setup



Configuring the *CPC 100*

The *CPC 100* must be configured for the *CP CU1*. To configure the *CPC 100*:

1. Press the **Options** view selector button to open the **Options** window.



2. In the **External booster** combo box, select **CU 1**.
   The **CT** and **VT** settings are set according to the built-in current and voltage transformers automatically.
3. Set the current range of the *CP CU1* using the current range switch (see page CP CU1-2) to the value configured by the *CPC 100* software.

Warning: Set the current range switch on the *CP CU1* front panel only when the *CPC 100* is turned off and the test object is connected to ground with closed grounding switch near the measurement setup.

Note: Current range settings on the test card and on the *CP CU1* front panel must be the same.

Connecting the *CPC 100* and *CP CU1* to Power Lines

Safety Instructions

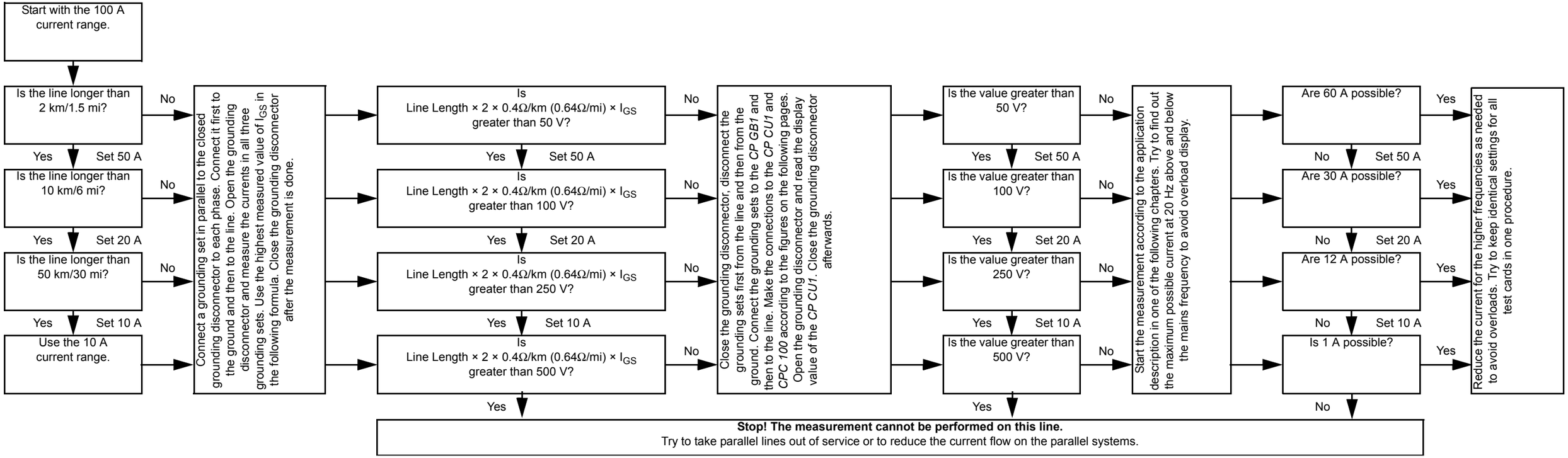
Warning: A lightning discharge to the line under test can cause injury or possibly death of the operating staff. Do not connect the measurement setup to overhead lines if there is a possibility of a thunderstorm over any part of the lines to be measured.

Warning: Connecting the measurement setup to overhead lines with a life parallel system brings about high-voltage hazards. It is strongly recommended to take all parallel lines out of service before proceeding

Warning: During the grounding switch at the near end of the power line is open, the area around the *CP GB1* in the range of 5 m/15 ft and around the *CP CU1* in the range of 2 m/5 ft is a dangerous zone due to high-voltage and mechanical hazards. Do not enter the dangerous zone. Keep the grounding switch open for a time as short as possible.

Warning: If you see or hear anything uncommon in the test equipment, e.g. noise of electrical discharge or lightening of surge arrestors, close the grounding switch before touching the measurement setup.

Connecting the *CPC 100* and *CP CU1* to Power Lines

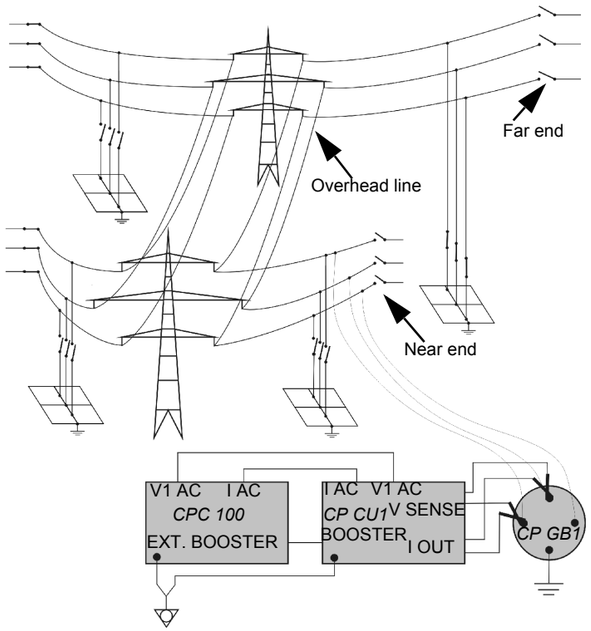


Applications and Test Templates

The following application examples show the typical usage of the *CP CU1*. The test procedures running on the measurement setup are controlled by templates available on the *CPC 100 Start Page*.

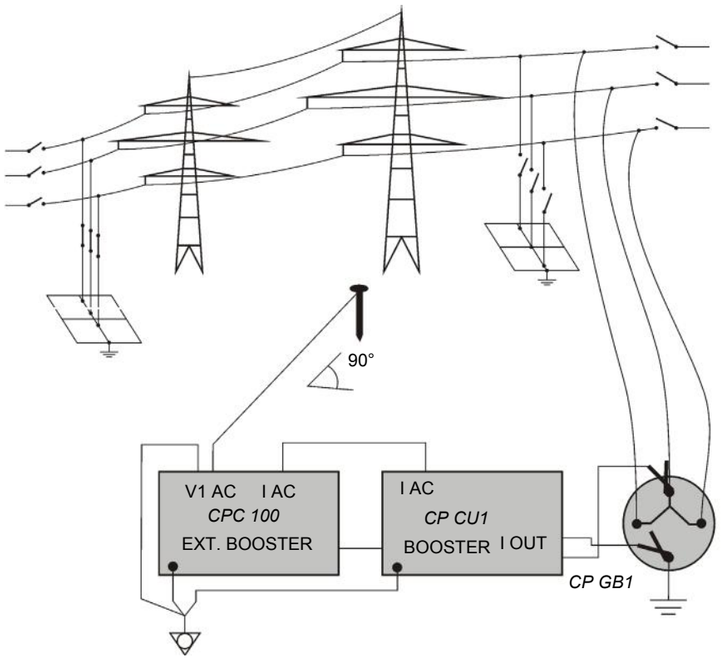
For detailed information on the *CP CU1* applications, refer to the CP CU1 Reference Manual delivered with the *CP CU1* or available in pdf format on the *CPC 100 Start Page*.

Line Impedance Measurement

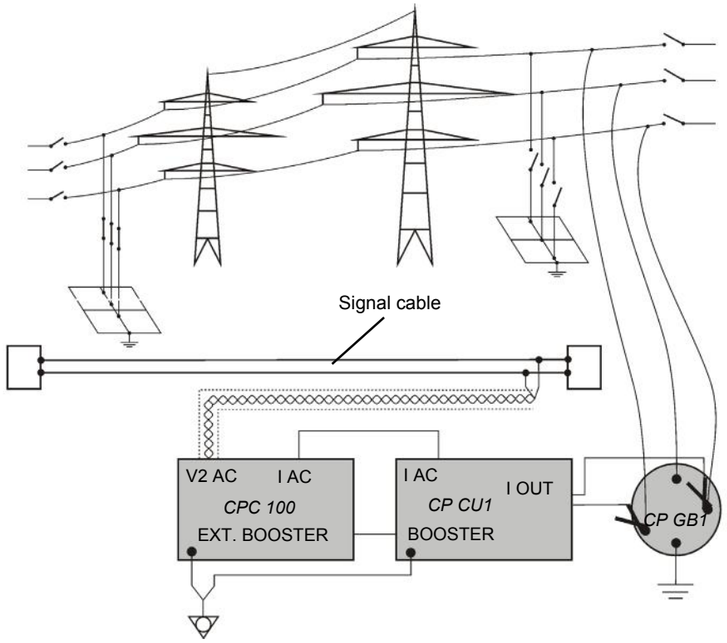


There are seven different measurement loops: A-B (shown here), A-C, B-C, A-G, B-G, C-G and ABC in parallel to ground (similar to the next figure).

Ground Impedance Measurement

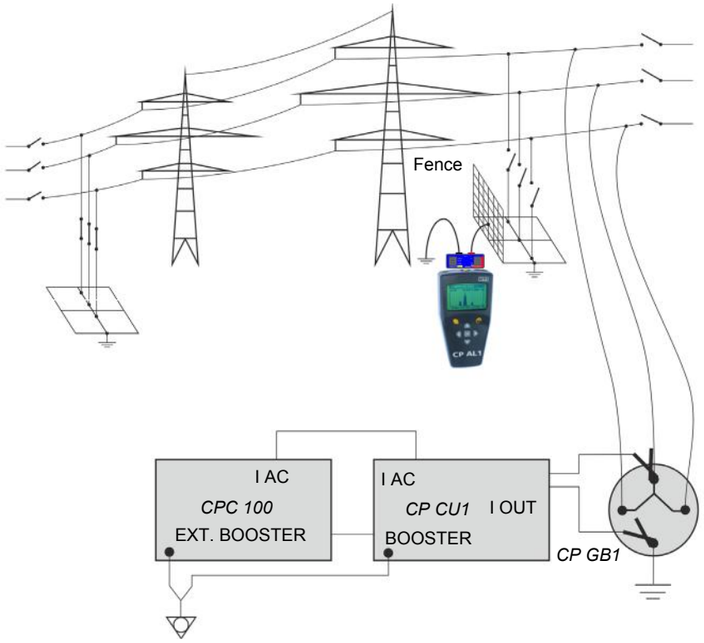


Measurement of Coupling into Signal Cables



There are four measurements with different connections. For detailed information, refer to the template or the CP CU1 Reference Manual.

Step and Touch Voltage Measurement



For the step and touch voltage measurements using the *CP AL1* FFT voltmeter, refer to the CP 0502 Application Note.

Technical Data

Output Ranges

Range	Current	Compliance Voltage @ > 45 Hz	
10 A	0 … 10 Arms	500 Vrms	5000 VA (45 … 70 Hz) cosφ < 1.0 @ 230 V AC mains voltage cosφ < 0.4 @ 115 V AC mains voltage for 8 s or 1600 VA continuously
20 A	0 … 20 Arms	250 Vrms	
50 A	0 … 50 Arms	100 Vrms	
100 A	0 … 100 Arms	50 Vrms	

Accuracy

Impedance Range	Typical Accuracy of abs(Z)	Typical Accuracy of Phase	V SENSE Voltage	I OUT Current	Current Range
0.05 … 0.2 Ω	1.0 … 0.5%	1.5 … 0.8°	5 … 20 V	100 A	100 A
0.2 … 2 Ω	0.5 … 0.3%	0.8 … 0.5°	20 … 50 V	100 … 25 A	100 A
2 … 5 Ω	0.3%	0.5°	100 V	50 … 20 A	50 A
5 … 25 Ω	0.3%	0.5°	100 … 250 V	20 … 10 A	20 A
25 … 300 Ω	0.3 … 1.0%	0.5 … 1.5°	250 … 500 V	10 … 1.5 A	10 A

CP SB1

Safety Instructions

Note: On principle, the safety instructions relevant to the *CPC 100* and its accessories (refer to page Preface-1) also apply to the *CP SB1*. This section lists safety instructions that exclusively apply to the *CP SB1*.

General

- Make sure to position the *CP SB1* in a safe area.
- Before connecting or disconnecting test objects and/or cables, turn off the *CPC 100* by either the POWER ON/OFF switch or the Emergency Stop button. Never connect or disconnect a test object while the outputs are active.
- Even if you switched off the *CPC 100*, wait until the red I/O warning light is fully extinguished. As long as this warning light is lit, there is still voltage and/or current potential on one or more of the outputs.
- When measuring the ratio of power transformers make sure that the test voltage is connected to the corresponding high-voltage winding, and the voltage of the low-voltage winding is the one that is measured. Accidentally mixing up the windings can generate life-threatening voltages within the transformer.
  For example: feeding a voltage of 300 V to the low-voltage winding of a power transformer that has a ratio of 400000 V : 30000 V, induces a voltage of 4000 V in the transformer's primary winding.
- Do not operate the *CP SB1* under ambient conditions that exceed the temperature and humidity limits listed in "Technical Data".
- If the *CP SB1* or any add-on device or accessory does not seem to function properly, do not use it anymore. Please call the OMICRON electronics hotline.
- Before handling the *CP SB1* or *CPC 100* in any way, connect them with a solid connection of at least 6 mm² cross-section to equipotential ground. Ground the *CP SB1* as close as possible to the *CPC 100*.
- For the connection between the *CPC 100* and *CP SB1* only use the specially manufactured cables supplied by OMICRON electronics.

DC Output to Test Objects with a High Inductance

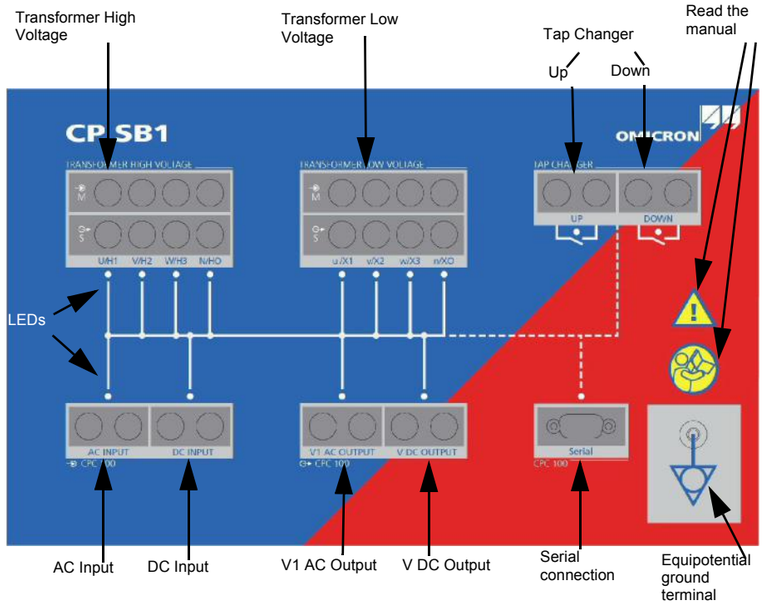
When using the DC Output to test power transformers with a high inductance, observe the following safety instructions:

- Use the **TRTapCheck** (tap changer winding resistance and on-load tap changer interruption check) test card only.
- As long as the *CPC 100* software shows the on-screen message "Switch off in progress", NEVER connect or disconnect test objects and/or cables.
- The message "Switch off in progress" notifies you that, while the *CPC 100* is deactivating, the connected external inductance (this means the test object) still "feeds" voltage potential back into the **6A DC** output.
- The existence of this voltage potential at the **6A DC** output is also indicated by a lit LED - even if the *CPC 100* is switched off.
- If a test object with a high inductance was connected to the *CPC 100*, short-out the test object additionally before disconnecting any cables.

Product Description - Designated Use

The *CP SB1* is a transformer switch box designated for automatically measuring the ratio and winding resistance, and testing the tap changer of three-phase power transformers. It is an accessory to the *CPC 100*. Automatic control of the On-Load Tap Changer (OLTC) is included. Testing of power transformers over all taps and all phases is fully automated. Therefore, no rewiring is required. The *CP SB1* is controlled from the *CPC 100* via its serial interface. The results are recorded in the *CPC 100* with the ratio and tap changer test cards, and can be analyzed with the computer tool set (*CPC 100 Excel File Loader*).

Functional Components of the *CP SB1*



The front panel of the *CP SB1* provides the following functional components:

- Transformer High Voltage:
  - Outputs (Source) for the injection of current or voltage on the individual phases of the transformer
  - Inputs (Measure) for the voltage measurement

  Note: The inputs and outputs of the respective connections (U/H1, V/H2, W/H3, N/H0) are connected to the transformer using Kelvin clamps.
- Transformer Low Voltage:
  - Outputs (Source) for the injection of current or voltage on the individual phases of the transformer
  - Inputs (Measure) for the voltage measurement

  Note: The inputs and outputs of the respective connections (u/X1, v/x2, w/x3, n/X0) are connected to the transformer using Kelvin clamps.
- Tap Changer: Two potential-free contacts for switching the tap changer
- AC input for connection to the **2KV AC** output of the *CPC 100*
- DC input for connection to the **6A DC** output and **I AC/DC** input of the *CPC 100*
- AC output for connection to the **V1 AC** input of the *CPC 100*
- DC output for connection to the **V DC** input of the *CPC 100*
- Serial interface for the *CPC 100* (**TRRatio** and **TRTapCheck** test cards) to control the *CP SB1*
- Equipotential ground terminal for grounding the *CP SB1* close to the position of the operating staff

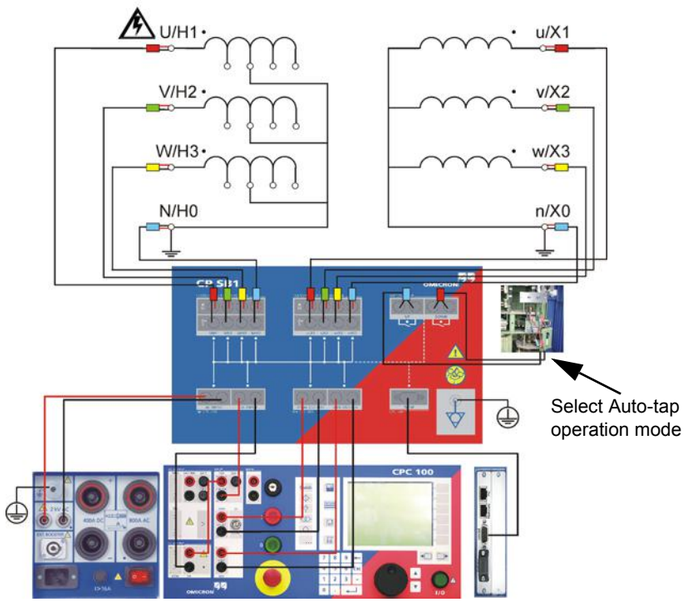
Connecting the *CPC 100* and *CP SB1* to Power Transformers

Safety Instructions

- Position the *CP SB1* in the safety area and do not enter this area during the entire measurement.
- Connect the *CPC 100* and *CP SB1* using the delivered grounding cable.
- Connect the grounding cable of the *CP SB1* at a safe grounding point at the transformer.

  Note: Do not operate the test equipment without safe connection to ground.
- Make sure that all high-voltage connections of the transformer are removed.
- Make sure that all terminals of the transformer are connected to ground.
- Switch off the power supply of the tap changer.
- Connect the Kelvin clamps to the bushings.
- Connect the cables to the Kelvin clamps. Make sure that the cables show upwards and that each colour is connected to a different phase.
- Connect the cables from the Kelvin clamps' voltage sense outputs to the *CP SB1*'s transformer inputs. Observe the color code.
- Make sure to measure the voltage to ground at the terminals of the tap changer. If no voltage is measured, connect the flexible terminal adapters to the "up" and "down" terminals of the tap changer.
- Connect the cables ("up", "down") to the *CP SB1*.
- Connect the *CP SB1* to the *CPC 100* according to "Functional Components of the CP SB1" on page CP SB1-2.
- Switch on the power supply of the tap changer.
- Remove all grounding connections of the terminals except one per winding. Use Neutral (N) for the grounding connection if accessible.
- Start the measurement according to page Transformer-1 and page Transformer-7.

Measurement Setup



Technical Data

Specifications

Characteristic	Range
AC Input / V1 AC Output	max. 300 Vrms
DC Input	max. 6 A DC
Transformer High and Low Voltage connections	max. 300 Veff between all connectors and ground
Tap Changer	Two potential-free contacts, short circuit-protected; 0-240 V AC (only AC permitted); Overvoltage Category II; Resistance per contact = max. 4 Ω I continuous = 0.9 A rms
Supply	Via serial interface from the *CPC 100* (+15 V)
Overvoltage protection to case with surge arrestors	All connections to Tranformer High and Low voltage side; AC/DC Input; V1 AC / V DC Output

Weight and Dimensions

		Weight	Dimensions (W x H x D)
CP SB1	test set	3.5 kg (7.7 lbs)	357 x 235 x 111 mm (14.1 x 9.2 x 4.4")
	test set & case	28.5 kg (62.7 lbs)	700 x 450 x 500 mm (27.6 x 17.7 x 19.7")

Environmental Conditions

Operating temperature	–10 … +55 °C (+14 … 131 °F)
Storage and transportation	–20 … +70 °C (–4 … 158 °F)
Max. altitude	2000 m
Humidity	5 … 95% relative humidity; no condensation Tested according to IEC 68-2-78
Vibration	Tested according to IEC 60068-2-6; frequency range 10 … 150 Hz; acceleration 2 g continuous (20 m/s^2); 20 cycles per axis
Shock	Tested according to IEC 60068-2-27 (operating mode); 15 g / 11 ms, half-sinusoid, 3 shocks in each axis
EMC	EN 61326-1 Class A IEC 61326-1 Class A FCC Subpart B of Part 15 Class A EN 61326-1 IEC 61326-1
Safety	EN 61010-1 IEC 61010-1 UL 61010-1
Suitable for usage according to	IEEE 510, EN 50191 (VDE 0104), EN 50110-1 (VDE 0105 Part 100)
Housing and transport case	IP20 according to EN 60529

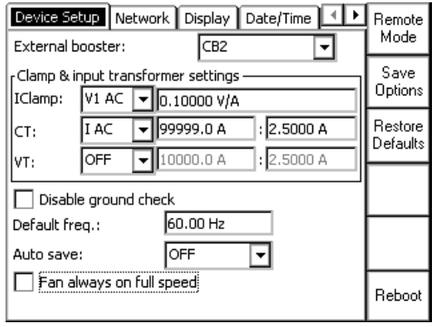
CP CB2

General

For test applications requiring up to 2000 A.

The output current of the *CPC 100* can be increased up to 2000 A by means of an electronically controlled current booster. The *CP CB2* can be connected close to the busbar using short high-current cables and to the *CPC 100* with a long control cable.

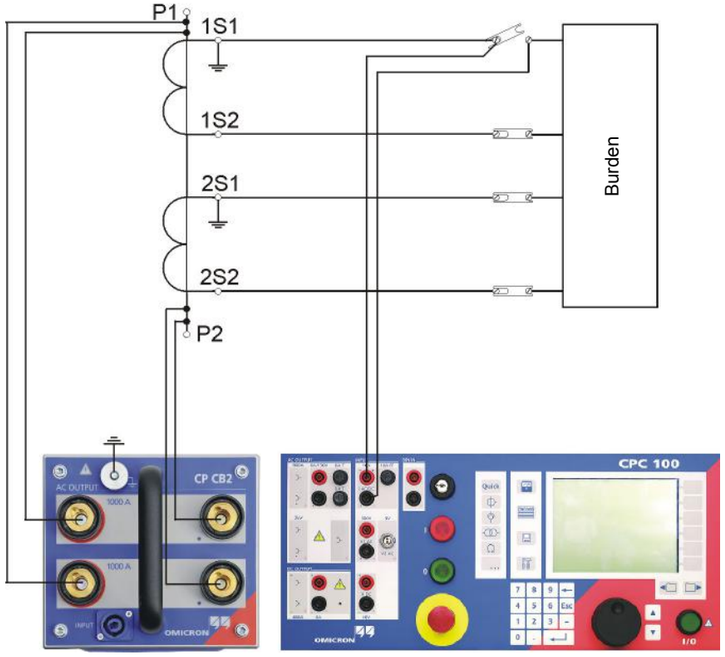
Select the *CP CB2* as external booster on the **Device Setup** tab in the **Options** menu:



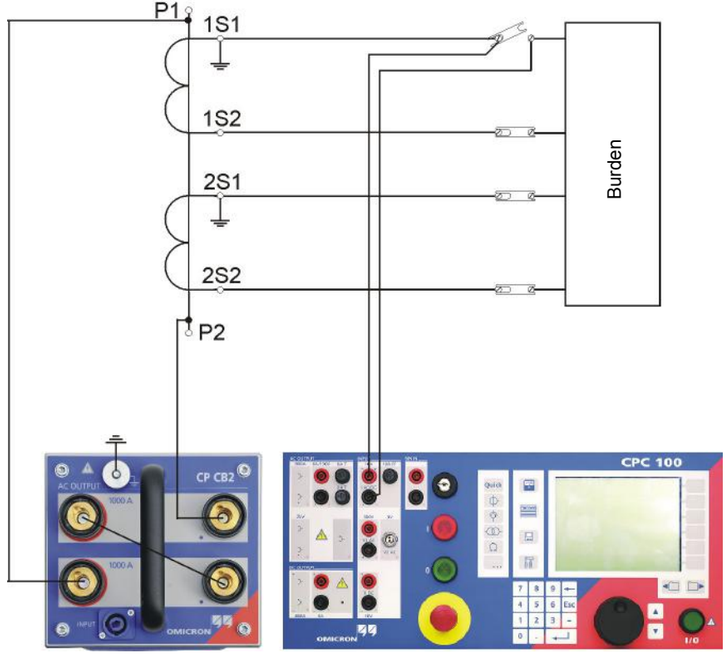
Note: If you select the *CP CB2* as external booster on the **Device Setup** tab in the **Options** menu, it will be saved as default value for new test cards. However, it is also possible to select the external booster individually on the test cards. The settings for already inserted test cards will only be changed if no test results are available yet.

Operation Modes of the *CP CB2*

2000 A mode:



1000 A mode:



Technical Data

Current outputs					
Range	**Amplitude**	**t_{max} [1]**	**V_{max} [2]**	**$Power_{max}$ [2]**	**f**
1000 A AC	0 … 1000 A	25 s	4.90 V	4900 VA	15 … 400 Hz
	0 … 500 A	30 min	5.00 V	2500 VA	15 … 400 Hz
2000 A AC	0 … 2000 A	25 s	2.45 V	4900 VA	15 … 400 Hz

Internal measurement of outputs						
Output	**Guaranteed accuracy**			**Typical accuracy**		
	Amplitude		**Phase**	**Amplitude**		**Phase**
	Reading error	**Full scale error**	**Full scale error**	**Reading error**	**Full scale error**	**Full scale error**
2000 A AC	0.25%	0.25%	0.50°	0.13%	0.13%	0.25°
1000 A AC	0.25%	0.25%	0.50°	0.13%	0.13%	0.25°

Weight and Dimensions

		Weight	**Dimensions (W x H x D)**
CP CB2	test set	16 kg (35.3 lbs)	186 x 166 x 220 mm (7.3 x 6.5 x 8.7”), without handle.
	test set & case	25 kg (55.1 lbs)	700 x 450 x 360 mm (27.6 x 17.7 x 14.2”)

Notes regarding the *CP CB2*

1. With a mains voltage of 230 V using a 2 x 0.6 m high-current cable at an ambient temperature of 23 °C ± 5 ° (73 °F ± 10 °F)
2. Signals below 50 Hz or above 60 Hz with reduced values possible

Caution: Make sure to establish series or parallel connection, depending on the selected range on the test card.